JOHN BENEDICT LUST, JR.

May 7, 2003

Office of the General Counsel for Ocean Services
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
1305 East-West Highway
Silver Spring, MD 20910

RE: Islander East's administrative appeal. Comments

Dear Sir or Madam:

Attached please find a copy of a letter sent to you May 8,2003 with attachments. This letter and these attachments were submitted to provide comment from the Town of Branford on Islander East's administrative appeal

At the time of mailing the town was not in receipt of its' final report on anticipated biological impacts associated with the Islander East proposal. We have now received this report and since the deadline for public comment has been extended, we would like to submit it for your review. Please find it attached.

Thank you again for this opportunity to respond.

Sincerely,

John B. Lust jr

John B. Lust jr

Attachments:
Letter of May 7, 2003 to U.S. Dept of Commerce
Engineering Report on Sedimentation Impacts by John Roberge P.E., L.L.C.
Cooperative Agreement Concept- Islander East Pipeline Co. / Iroquois Gas Transmission Co.
Preliminary Report on the Anticipated Biological Impacts Associated with the Proposed Islander East Pipeline Project

3 Waverly Road • P.O. Box 615 • Branford, Connecticut 06405-0615
(203) 488-0765 • email: johnblust@rcn.com

JOHN BENEDICT LUST, JR.

May 7, 2003

Office of the General Counsel for Ocean Services
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
1305 East-West Highway
Silver Spring, MD 20910

RE: Islander East's administrative appeal. Comments

Dear Sir or Madam:

As you are aware, Branford Connecticut is the community most threatened by Islander East's natural gas pipeline proposal. This is true because the community stands to be impacted both in sensitive upland areas as well as in offshore shellfish areas.

I chair Branford's Blue Ribbon Committee which was established to study Islander East's natural gas pipeline proposal. To that end our committee has researched extensively. We have also commissioned experts in the fields of Coastal Engineering and Benthic Science to determine for ourselves the potential impacts and to evaluate information supplied to the regulating agencies by Islander East regarding impacts.

These studies and the committee's research have revealed two main points and these are the bases for our comments to you in the appeal:

1. The environmental impacts have been understated or misrepresented by Islander East both in the upland areas and offshore. Offshore, in the application you are reviewing, the proposed dredging with side-casting is minimized. However, our engineer's report indicates that the side-cast mounds in their entirety could be dispersed in a single storm. In addition, our engineers indicate that suspended sediments from the initial one mile clamshell dredge operation could extend as far as 1,000 meters from the trench centerline impacting as many as 1,700 acres in the shellfish bed areas proximal to the Thimble Islands. This initial dredge operation alone renders this project inconsistent with Coastal Zone Management guidelines. (Please see the attached engineering study on potential sedimentation impacts. We also have a correlating benthic study available on request.)

2. Early in our research we discovered that Islander East's proposal was conceived out of self interest not public need as there are more suitable alternatives. In particular, the Iroquois Gas Transmission Company has had a similar route planned to Long

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Island called the Eastern Long Island Extension. This route, originating two miles off shore in Milford, CT, has minimal environmental impacts, could be completed in a minimal amount of time and is welcomed by Milford. The Iroquois Gas Transmission Company has opted not to build the extension so it is available to Islander East and could be directed so by the FERC. (See attached plan of cooperation.) (Note: The Iroquois line ties into the same natural gas infrastructure in CT and boasts a direct line to Canada as well. Iroquois has FERC approval to tie into the Algonquin system as Islander East intends to do.)

These two very important points signify first that Islander East's proposal is not consistent with Coastal Zone Regulations and second that the issue is moot as there is an alternative available that is consistent.

Thank you for this opportunity to provide comment.

Respectfully,

John B. Lust

Attachments:
Engineering Report on Sedimentation Impacts by John Roberge P.E., L.L.C.
Cooperative Agreement Concept-Islander East Pipeline Co. / Iroquois Gas Transmission Co.

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COOPERATIVE CONCEPT
ISLANDER EAST AND IROQUOIS GAS TRANSMISSION COMPANY WORKING TOGETHER TO PROVIDE GAS TO EASTERN LONG ISLAND

Prepared by:
Branford's Blue Ribbon Committee

John B. Lust, chairman

In its Final Environmental Impact Statement (FEIS) for Islander East LLC, the Federal Energy Regulatory Commission (FERC) has recognized a less environmentally damaging System Alternative to Islander's proposed pipeline project. That alternative follows the route from Milford, CT to Wading River, NY currently proposed by the **Iroquois Gas Transmission Company** for its Eastern Long Island (**ELI**) Extension. This alternative involves installing a single pipeline from the existing Iroquois pipeline at a point about 2 miles off-shore Milford, CT, across Long Island Sound to Eastern Long Island. After a review of both proposals it is clear that the Iroquois **ELI** extension alternative offers a solution to .ong Island's energy needs that will be quicker to install while minimizing impacts to Connecticut's upland and offshore environments. It also provides better and more reliable gas service to NY.

The FERC stated that it chose to certificate the more environmentally damaging Islander East project in part to increase the diversity of transport options. The FERC, however, failed to recognize another potential means to reach its stated objective without damage to the environment. That alternative would be for **Islander East** to construct and operate a pipeline from the Iroquois pipeline off-shore Milford, CT to Long Island. By making use of existing Iroquois infrastructure, this plan offers the least environmental impact while allowing ultimate capacity to be determined by prevailing market forces as the FERC states it wishes.

The purpose of this communication is to compare the costs and benefits of this alternative with the current Islander East proposal, not to second-guess the FERC on how ownership and management of the new pipeline might be structured. It could be a joint venture between Iroquois and Islander East, or Islander East could own and operate the pipeline independently. Having Islander East involved in some way however, would help ensure a measure of competition in the Long Island energy market. And, in fairness to Islander East, their efforts to supply Long Island with natural gas would not be at a loss.

CONCEPT OF COOPERATION

That the proposed Iroquois Gas Transmission Company's ELI System alternative be accepted as the means of supplying natural gas to Eastern Long Island, but that Iroquois Gas Transmission Company control only its present system and any upgrades on land in Connecticut that are necessary to meet the market demand on Long Island

That Islander East then build, own and be responsible for operating the extension from offshore in Milford, across Long Island Sound to its' proposed system on Long Island. Because Islander East LLC and the Iroquois Gas Transmission Company are two competing companies, this relationship may have to be directed by the FERC. However, under this arrangement Long Island would get the gas it needs at the correct pressures in the shortest possible time.

Both of these competing companies would profit although each to a lesser extent, the environmental impact to Connecticut, Long Island Sound and Long Island would be minimized, the size of the system would be determined by market demand and last but not least, we would be supporting the sensible concept of cross-Sound corridors for utilities.

ANALYSIS OF NEED

The Islander East proposal and the Iroquois proposal, until recently, were competing proposals. Iroquois anticipates much lower energy needs on Long Island now and for the future and in fact has withdrawn their application because of their inability to secure contracts.

2. FERC has stated they do not wish to determine exactly what the energy needs of Long Island are. Rather, they have established that there is a need and would like the market to determine its' depth. This proposal allows that to happen
3. If KeySpan has, as Iroquois predicts, inflated the energy demand figures and Islander East gets to build their project in a poor market, then the development costs for the project will be passed on to New York consumers. This will unnecessarily inflate energy costs in the region. (There is federal regulation of gas prices, however, there will also be pressure on the FERC to pass these costs along to the consumers because KeySpan would control shipping which is regulated by the FERC.

Factors that favor the use of the Milford route:

1. The use of the single pipeline from off-shore Milford, CT, to Shoreham, NY, minimizes impact to Long Island Sound by having a route across the Sound that is approximately 5.5 miles (25%) shorter than the Islander East proposed line and by reducing the length of shellfish bed crossed by more than 60% (only 25% of one commercial fishing lease is impacted along it's entire route). It also eliminates the mounding of tens of thousands of cubic yards of sediment in a near-shore area. These mounds will be subject to massive erosion and sediment distribution by waves generated in even moderate wind events, leading to unnatural amounts of sediment dispersion onto Stony Creek shellfish beds.
2. The Iroquois pipe is stronger then the proposed Islander linc and according to Iroquois engineers, has been tested to withstand "anchor drops" typical of ocean going vessels.
3. The existing Iroquois upland system is a far safer system than that which Islander East proposes to build. The Iroquois system is a class 3 system with a greater wall strength then Islander's proposed system and additionally, it is encased in concrete to ensure safety. It is also pressure tested to 2200 psi. A system of this type, according to Iroquois engineers, is generally considered impenetrable. Islander East's system is not. Neither is the aging Algonquin system that Islander East proposes to tie into. The Iroquois system ties into all the Northeast's gas infrastructure (including Algonquin's) but in addition has a class three line running straight North into Canada.

4. The Iroquois System is a higher pressure system (700 psi delivered to Long Island) then that proposed by Islander East (366 psi to Long Island). Power plants on Long Island will require between 550 and 600 psi guaranteed continuous pressure. Thus, the Islander East system will not be able to supply gas at pressures required by power plants, the principal users of this gas. This fact necessitates the construction of compressor stations on Long Island. The higher operating pressure of the Iroquois system eliminates the need for compressor stations on Long Island making their proposal better environmentally for New York.
5. Because of its' simplicity, the basic Iroquois ELI project could be completed and in place in a much shorter time frame (17 days to the Long Island shore following tie in to the system). There is little upland and no HDD with its' uncertainty of success.
6. The level of market demand estimated by Iroquois could be met by adding one compressor station (on land already owned by Iroquois that borders a closed landfill and welcomed by Milford due to the tax revenues anticipated) to the existing capacity of the Iroquois system, virtually eliminating impacts to upland and coastal resources.
7. Should the market projected by Islander East eventually materialize, the Iroquois system could be expanded to meet any possible energy demands with 6.5 miles of loop that could be installed anywhere along the existing Iroquois upland route. This is far less upland impact than what Islander East proposes.

8. Utilizing the Iroquois alternative therefore eliminates the necessity of resolving the need analysis argument. Current needs can be met immediately with minimal environmental impact. Actual market demand can then effectively determine what and when expansion of the system is required. This is the FERC's stated preference and in fact ensures that the environmental impact will be limited to only what is necessary to meet Long Island's need. (There is ample lead-time in evaluating need as it develops because of the permitting and construction process for power plants.)

9. Utilizing the Iroquois Extension would be consistent with Connecticut and New York's interest in establishing corridors for utility and communication crossings of the Sound.

REPORT OF FINDINGS

TOWN OF BRANFORD, CT
Long Island Sound

POTENTIAL SEDIMENTATION IMPACTS WHICH COULD RESULT FROM DREDGING

MP 10.9 - MP 12.0
Proposed Construction of The Islander East Gas Transmission Pipeline

Prepared For
The Town of Branford

Revision Date: May 5, 2003

Prepared By

JOHN C. ROBERGE, P.E., LLC
COASTAL ENGINEERING
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TOWN OF BRANFORD, CT
Long Island Sound

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EXECUTIVE SUMMARY

Potential sedimentation impacts which could result from construction dredging, proposed for the installation of the Islander East Gas Transmission Pipeline were evaluated by **JOHN C. ROBERGE, P.E., LLC** at the request of the Town of Branford. The proposed construction operations include dredging of approximately 51,000 cy of bottom sediments to construct a basin and pipeline trench. The project proponent originally planned to place the dredged material onto subaqueous mounds adjacent to the pipeline trench. The dredged material management methods have been altered, as reflected in documentation provided by the project proponent modifying the regulatory permit applications, to include placement of the dredged materials onto barges.

It was demonstrated that turbidity levels and sediment deposition, resulting from the proposed construction of the Islander East Pipeline Company, LLC natural gas pipeline, will potentially and significantly impact the adjacent waters of Long Island Sound.

The anticipated turbidity levels and deposition will be highly dependent upon the rate of initial sediment release at the dredging position. Empirical values of sediment release rates for comparable observed dredging operations were employed to develop limits of potential suspended sediment plumes which could result from the pipeline construction operations in the vicinity of MP 10. 9 to MP 12.0. Suspended sediments could extend as far as 1000 meters from the centerline of the proposed pipeline trench and impact an area of as much as 1,700 Acres in the vicinity of the Thimble Islands in Long Island Sound. It is significant to note that the construction operations proposed by Islander East will involve, not just the initial construction dredging of the basin and trench, but will require the backfilling of the open trench to provide cover for the installed pipe. The impacts of the dredging will be effectively doubled. It was demonstrated that sediment deposits of up to 2.7 mm could result from the dredging operations in areas adjacent to the trench and that the backfilling operations could potentially double that accumulated mass.

The disposition of the dredged materials have not be completely described by the Islander East Pipeline Company, LLC. Alternatives include: placing of approximately 10,000 cy into the trench for protective cover of the installed pipeline; disposing of the remaining materials at the open water disposal sites in Long Island Sound; disposing of the remaining materials at yet undefined upland sites; covering the installed pipeline with engineered backfill; or a combination of each of these methods. It is anticipated that between 41,000 and 51,000 cy of the materials dredged from the HDD basin and pipeline trench could be disposed at the open water disposal facilities in Long Island Sound. It is essential that these materials be sufficiently characterized, including biological assessments, in accordance with the letter and intent of the Federal Marine Protection, Research and Sanctuaries Act.

It is essential that the potential impacts upon pelagic, demersal and benthic fauna as well as subtidal flora imposed by the sedimentation processes be evaluated and quantified. Mitigation measures and operational constraints should be considered by regulatory authorities to minimize potential impacts. Similar dredging and construction operations have included a range of effective measures, including but not limited to:

Restricted temporal windows for operations to assure minimizing impacts upon potentially effected fauna and flora, including restriction of operations during the spawning periods of species indigenous to the project area;

Prohibition of stockpiling or sidecasting of dredged materials, requiring temporary storage of those materials on sealed floating barges;

Implementation of sealed dredge buckets to minimize re-entrainment and release of sediments into the water column during hauling operations;

Environmental sensitivity training for all dredge operators to assure knowledge of means and methods to minimize sediment release into the wqater column during dredging;

Imposing operational limits for sediment plume release size and concentration upon the dredging contractor and require termination of the dredging should those limits be exceeded;

Requiring "third-party oversight" of all operations and monitoring and assigning authorization to that entity to shut down the operations should operational limits be exceeded;

Requiring the dredging contractor to prepare and implement a ***Construction Mitigation Plan***, clearly defining all of the means and methods which he proposes to employ to minimize construction impacts.

Imposing strict ***Best Management Practices*** upon the trench backfilling operations by requiring sediment plume size to be limited, imposing placement methodology restrictions, and related restrictions.

1.0 Potential Turbidity Plume and Sediment Deposition From Dredging Operations

1.1 Introduction

The 24" natural gas pipeline, proposed to be placed on the bottom of Long Island Sound and extend from Branford, CT to Wading River, NY, will include a dredged basin to accommodate the transition from the HDD operation and a 1.2 mile long pipeline trench to be excavated by traditional mechanical dredging operations (Islander East Pipeline Company, LLC, Ref. 1). It was originally proposed by the project proponent that materials dredged from the transition basin and the pipeline trench would be placed on the ocean bottom in mounds adjacent to the dredged areas. Islander East Pipeline Company, LLC revised this proposed dredged material management method to that described in their "Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications, (OLISP) Permit #200200761" and dated March 14, 2003 (Islander East Pipeline Company, LLC, Ref. 2). The modified method is to include placement of the dredged materials on barges. The proponent further notes that they propose to backfill the trench after placement of the pipeline to a depth such that 18" of cover are provided over the pipe. No further clarification of the methodology is provided in the permit modification document. It would appear that the ultimate fate of a significant volume of the material removed from the basin and trench, i.e. in fact approximately 78% of the material to be dredged, has not be identified. The proponent has noted that they are "consulting with federal agencies on wether to dispose of the dredged materials offsite and/or return the material to the trench". It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to approximately 40,000 CY, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

It is anticipated that the HDD transition basin will be located near Mile Post 10.95. This basin is proposed to be approximately 250' in length and 130' in width with a maximum depth of 20'. The dredged pipeline trench will extend from the transition basin to Mile Post 12.0. Water depths in this area were readily available from NOAA navigation charts. The transition basin and dredged pipeline trench areas are characterized by a gently sloping bottom, with depths ranging from approximately 12' (MLW) in the area of the transition basin to about 22' (MLW) at the southern extent of the trench. Approximately 6,500 cy of sediment will be dredged from the basin and placed on the barges as currently proposed by Islander East Pipeline Company, LLC. As noted, the ultimate fate of about 78% of that volume has not been identified.

The pipeline trench will be dredged by mechanical bucket dredge. The trench will be dredged to a depth of approximately 8' below the natural bottom and anticipated side slopes of 3:1, creating a trapezoidal section. Approximately 44,680 cy of sediment will be removed from the trench and placed onto barges as described above. After the 24" pipeline is placed into the trench, it is anticipated that a portion of the dredged materials will be used to backfill the trench and provide 18" of cover over the pipe. Islander East Pipeline Company, LLC has not identified the ultimate disposition or use of the materials remaining from the dredging operations. Neither the placement methodology nor the Best Management Practices (BMP's) to be employed by Islander East Pipeline Company, LLC during the backfilling operations have been identified. The effects of the potentially significant turbidity and material deposition within sensitive benthic communities which could result from the backfilling operations have not been quantified by Islander East.

1.2 Background

Dredging operations at the transition basin and along the pipeline trench route have the potential to affect local sediment transport systems and/or the local ecosystems. Evaluation of each of these sites included an estimate of the worst-case suspended sediment plume which could result during the dredging procedures and an estimate of potential sediment deposition depths in areas adjacent to the trench and pipeline construction. The worst-case plume condition was approximated using empirical information, available for the site or available from representative historic dredging operations and reported in available literature.

The potential spatial impacts of the transition basin construction and the trenching operations included a quantitative estimate of the mass of sediment which could impact adjacent resources. Potential suspended sediment levels were quantified utilizing the steady governing equation for a dynamically passive suspended plume (Teeter, Ref. 3). As noted, this assessment will yield worst-case centerline concentrations, demonstrating maximum potential impacts of the plume on adjacent resources. The direction of plume propagation was assumed to be coincident with the direction of the predominant tidal currents at each site, as predicted by NOAA. The tidal current vectors used in this assessment vary from those employed by the Islander East Pipeline Company, LLC. That variation is discussed in this analysis.

1.3 Historical Experience

Observations of pipeline trenching operations (Bohlen, Ref. 4) in Long Island Sound were made in 1991 to quantify potential sedimentation impacts upon adjacent oyster beds. The trenching operations included excavation of a trench, utilizing a large volume (13-22 CY) mechanical clamshell dredge, sidecasting the dredged materials along the adjacent margin of the trench, and backfilling of the trench from the margin after the pipeline was placed. The bottom materials at this site were primarily medium sands with occasional intrusions of coarse sands, gravel and mixtures of silt. The observation area was characterized by background concentrations of suspended materials which averaged between 5 and 10 mg/L. The Long Island Sound data indicated that suspended sediment concentrations within the turbidity plumes, associated with the pipeline installation procedures, decayed rapidly with distance downstream with the majority of sediment resuspended by the dredge settling within 30 -

60 m of the operation. The field observations noted further that suspended sediment concentrations within the immediate vicinity of the dredge bucket ranged from 50 to 250 mg/L. These observations appear to be consistent with other dredging operations performed in both sand and fine grained materials (Bohlen, Ref. 5). Comparable values for a range of bottom material types are shown in Table 1. The observations further noted that the near-bottom suspended material field was essentially confined to a region extending between 450 m and 920 m downstream of the operating dredge.

Table 1
Historical Suspended Sediment Plume Characteristics
For Dredging Operations

Location	Water Depth (m)	Ave. Current Speed (cm/s)	Distance From Source (m)	Ave. Sediment Concentration (mg/L)
	0.5		7	105
Hori River	1.5		7	70
Nagoya, Japan	2.5		7	20
	0.5		13	-
Watertight	1.5	n/a	13	25
Bucket	2.5		13	13
(Ref. 6)	0.5		23	-
	1.5		23	-
(Note 1)	2.5		23	30
St. Johns River Jacksonville, FL (Ref. 7)	5.18	4.9	15	48
			30	214
			61	118
			122	50
			244	24
Black Rock Harbor Bridgeport, CT (Ref. 7)	6.1	6.7	30	281
			61	179
			122	95
			244	58
			488	77
Thames River New London, CT (Ref. 5)	11.0	15	33	86
			66	37
			100	22
			166	7
			233	5.5
			330	3.5

Note 1: Open bucket of similar size resulted in average sediment concentrations 1.56 times greater than closed bucket.

The dredging operations summarized on Table 1 were performed at sites with sediment characteristics comparable to the Islander East sites in the vicinity of the Thimble Islands in Branford, CT. The Hori River site included sediments which were predominantly clay and silt in water depths of approximately 3 m. The St Johns River operations were performed in silty sediments. Comparable bucket dredging operations in Black Rock Harbor and the Thames River included the dredging of primarily fine grained sands and silts. The plume generation associated with the Long Island Sound trenching work appeared to be confined to the dredge operational period with suspended sediment concentrations returning to pre-project levels almost immediately following cessation of the trenching operations. As noted (Bohlen, Ref. 4), this factor serves to reduce the time during which benthic or sessile organisms will be exposed to elevated suspended material concentrations.

It was further noted (Bohlen, Ref.4), based upon the Long Island Sound trenching observations, that the discrete nature of the pipeline construction techniques suggested that it is appropriate to treat the operation as a moving point source of suspended materials. The source of suspended sediment will move progressively along the axis of the pipeline with resulting suspended materials distributed to either side of the pipeline under the alternating influence of local tidal currents.

1.4 Assessment of Proposed Dredging Operations

To assess the potential spatial impacts of the Islander East dredging operations and to provide a quantitative estimate of the mass of sediment which could potentially impact adjacent resources, the dredging locations were evaluated utilizing the steady governing equation for a dynamically passive suspended plume (Teeter, Ref. 3). Simplifying the governing equation to a one-dimension expression, the solution for suspended sediment concentrations along the resulting plume centerline was expressed as:

$$C = [Q_s / (2HV_sX)]\, e^{-(PWX/HU)}$$

Where:
C = Depth Averaged Suspended Sediment Concentration, mg/L
Q_s = Release Rate of Suspended Material at Source, g/s
H = Depth, m
U = Current Speed, cm/s
V_s = Horizontal Diffusion Velocity = 0.11(U)
P = Depositional Probability
W = Sediment Settling Velocity
X = Distance From Source, m

The expression was simplified to $C = [Q_s / (2HV_sX)]$ since the maximum value of the exponential term is unity. It is anticipated that this simplification will yield conservatively high or worst-case centerline concentrations, demonstrating maximum potential impacts of the plume on adjacent resources. The direction of plume propagation was assumed to be coincident with the direction of the predominant tidal currents at each site. Solving the one-dimensional expression for various values of X, distance from the source, correcting that distance to determine the distance normal to the trench centerline, and tabulating the results generates a series of characteristic suspended sediment concentrations, C, for each location. The distance, d, normal from the centerline of the pipeline trench, was determined by the simple computation:

$$\mathbf{d_{Flood} = X_{Flood}\ sin(a)_{Flood}} \quad \text{or} \quad \mathbf{d_{Ebb} = X_{Ebb}\ sin(a)_{Ebb}}$$

Where: d = Distance Normal From the Pipeline Axis
X = Modeled Distance From Source
a = Angle Between Tidal Current Direction and Pipeline Axis

The strength of the sediment source, R, is an empirical quantity. The value of the source strength, as generated by mechanical bucket dredge operations, has been observed (Collins, Ref. 7) to be dependent upon equipment geometry, operating characteristics such as speed and cycle time, depth of influence, and related characteristics.

Typical values of depth-averaged suspended sediment concentrations along the centerline of dredge buckets during water entry and withdrawal operations ranged between 50 - 500 mg/L. Typical values of initial sediment source release rates, as observed at several comparable operations, are summarized in Table 2. These values are typical of open bucket, and in several cases include closed-bucket, dredging operations and were used to quantify the range of potential impacts which could result from the Islander East dredging operations.

Table 2
Open Bucket Resuspended Sediment Source Strengths (Ref. 7)

Site	Source Strength, R (g/s)	Observed Source Concentration, (mg/L)
Black Rock Harbor	1,684	520
Calumet River	243	75
St. Johns River Jacksonville, FL	445	250 (Open Bucket) 150 (Closed Bucket)
Lake City (Note 1)	n/a	55 (Open Bucket) 150 (Closed Bucket)

Note 1: Sidecasting operations

The limit of the zone of influence was chosen to be that distance at which the ambient velocity was equivalent to the critical velocity (V_{CRIT}) required to maintain suspension of quartz sediments coarser than 200M (Vannoni, Ref. 8). V_{CRIT} for these sediments will be about 0.42 ft/s. The extent of the zone of influence, or the distance over which the initial sedimentation would take place will be approximately 55-ft or about 17-m. It was assumed that the released sediments at the dredging locations would be suspended over the entire water column due to the relatively shallow depths at these sites and that the coarse fractions would settle within 17m of either side of the trench. The characteristics of the Islander East dredging locations are summarized on Table 3. The general site characteristics include the site name, water depth, anticipated trenching technique, tidal current speeds, and average current directions referenced from the pipeline axis.

Plume generation and sedimentation potential at the dredging sites were simulated, based upon various initial sediment release rates. The sites are characterized by relatively typical sediment types. Each site includes observed fine lean clay and elastic silts, clays and traces of organics. The sediments were shown to display moderate plasticity. The average total unit weight of samples taken from the study areas, as reported by the project proponent, ranged from 89.6 to 94.9 pcf.

Table 3
Islander East Site Characteristics

Characteristic	Site		
	MP 10.90	MP 11.5	MP 12.0
Trenching Method	Mechanical Dredging	Mechanical Dredging	Mechanical Dredging
Depth, m (MLW)	4.0	5.1	6.4
Peak Flood Current, cm/s	57.0	57.0	57.0
Direction of Flood Flow	265°	265°	265°
Peak Ebb Current, cm/s	72.0	72.0	72.0
Direction of Ebb Flow	82°	82°	82°

The results of the Islander East plume simulation, detailed on the computation sheets provided in Appendix A, are summarized in Table 4. These tabulated values represent the potential increase, above ambient conditions, which could be expected for suspended sediment concentrations resulting from the basin construction and trenching operations. It must be noted that the initial rate of sediment release and thus the sediment plume characteristics will be highly dependent upon the travel speed of the dredge bucket, skill of the operator, quality of the bucket and scow equipment, and related operational issues. Variation of the travel speed with depth, sediment types, wind and wave conditions, surface support efficiency and other unforseen conditions should be anticipated.

Table 4
Islander East Pipeline Construction
Potential Suspended Sediment Concentrations At Centerline of Turbidity Plume (mg/L)

Station	Current Condition	Normal Distance From Trench Centerline, m (Note 1)							
		5	20	80	100	200	300	400	1000
R=1,684 g/s									
MP 10.9	Flood	671	168	42	34	17	11	8	3
	Ebb	354	89	22	18	9	6	4	2
MP 11.5	Flood	527	132	33	26	13	9	7	3
	Ebb	299	75	19	15	7	5	4	1
MP 12.0	Flood	420	105	26	21	10	7	5	2
	Ebb	253	63	16	13	6	4	3	1
R=445 g/s									
MP 10.9	Flood	177	44	11	9	4	3	2	1
	Ebb	94	23	6	5	3	2	1	0
MP 11.5	Flood	139	35	9	7	3	2	2	1
	Ebb	79	20	5	4	2	1	1	0
MP 12.0	Flood	111	28	7	6	3	2	1	1
	Ebb	67	17	4	3	2	1	1	0

R=243 g/s

MP 10.9	**Flood**	**97**	**24**	**6**	**5**	**2**	**2**	**1**	**0**
	Ebb	**51**	**13**	**3**	**3**	**1**	**1**	**1**	**1**
MP 11.5	**Flood**	**76**	**19**	**5**	**4**	**2**	**1**	**1**	**0**
	Ebb	**43**	**11**	**3**	**2**	**1**	**1**	**1**	**0**
MP 12.0	**Flood**	**61**	**15**	**4**	**3**	**2**	**1**	**1**	**0**
	Ebb	**37**	**9**	**2**	**2**	**1**	**1**	**0**	**0**

Note 1: Does not include dredged materials relocated to the immediate vicinity of the trench.

The results of the suspended sediment plume analyses are graphically depicted on Figures 1 - 4, as provided in Appendix A of this report. Figure 1 depicts the approximate route of the proposed pipeline and position of the HDD transition basin. The project site is located west of the Thimble Islands in relatively shallow water. Figure 2 depicts the approximate spatial limits of the potential plume which would be formed by the dredging operations and assuming a sediment release rate of 1,684 g/sec.

The sediment release rate is an empirical value, determined from literature describing comparable dredging operations. Sediment is released from the dredging site through a combination of actions, including but not necessarily limited to: the dredge bucket impacting the ocean bottom; dragging of the bucket on the bottom; the shedding of sediments from the bucket as it is hauled through the water column; and related operational parameters. While an empirical sediment release rate of 1,684 s/sec is the highest observed at other sites, it must be assumed that such rates are likely to be realized at the Islander East site based upon their lack of identified Best Management Practices and commitment to operational controls.

For comparison, the analyses included development of potential suspended sediment plumes for lower observed sediment release rates. Figures 3 and 4 provide graphic representations of the extent of the likely plumes which would result from dredging operations with sediment release rates of 445 g/sec and 243 g/sec, respectively.

The quasi-steady tidal current vectors, employed in these analyzes, were based upon the observed tidal vectors as reported by the National Oceanic and Atmospheric Administration and universally reported in commonly used tide charts and related publications. These analyzes represent the maximum conditions that can be anticipated at the project site. Site specific tidal current observations, reported by the project proponent (Bohlen et. al, Ref. 9), indicated that maximum near-bottom tidal currents were approximately 45 cm/sec, with flooding currents typically exceeding ebb. Bohlen further notes a general net transport to the northwest resulting from the asymmetry of the tidal current intensities. He notes that the nearshore reaches of the project site will be influenced by the islands and rocky outcrops and that net transport results from a dominance of the ebb currents in a generally northeast direction. He notes further that his observations clearly reflect the importance of wind induced velocities in these shallow water areas. The Bohlen report concludes "that the plume of sediments resuspended by the dredge will for the most part spread laterally to the east and west of the trench centerline due to the dominance of the east-west tending tidal currents."

The results of the analyses provided in tabular format and graphically depicted in Appendix A, clearly demonstrate the east-west tendency for plume dispersion. Magnitudes of turbidity concentration are dependent upon the magnitude of the tidal current velocity employed in these numerical simulations. Maximum tidal current velocities, representative of near-surface NOAA observations, were employed to generate potentially "worst-case" conditions which will result from the dredging operations. The time of dredging, position of the dredge, time in the tidal cycle, and related daily operational conditions can not specifically predicted and modeling all of the permutations and combinations of these performance criteria would be an overwhelming task. Consequently, demonstrating the "worst-case" operational scenario, by assuming maximum potential near-surface tidal currents and maximum sediment release rate represents a maximum potential impact to the surrounding benthic communities. No less than the maximum impact should be used to evaluate the impacts imposed by this proposed dredging operation.

It was estimated that a conservative approximation of deposited sediment thickness, resulting from the generated turbidity plume in the areas adjacent to the trench, could be developed by assuming that all of the materials suspended into the turbidity plume would be deposited at the maximum extent of transport. The deposition of sediment suspensions is analogous to marine gravity currents (Simpson, Ref.10). The mechanics of settlement at these sites, based upon the relatively high initial concentrations, will be dominated by the mass settlement of the suspension as opposed to gravimetric settlement of individual fine particles. The relatively fine characteristics of the sediment suspensions anticipated at these sites will result in visible plumes over a fairly broad expanse adjacent to the pipeline trench and as influenced by the local tidal currents.

Table 5 summarizes these estimated layer thickness as a function of distance, normal to the pipeline axis. This anticipated deposition will generally be a relatively thin veneer of typically mobile sediments. It is anticipated that the coarser fractions of the trench excavation will be placed immediately adjacent to the trench. These materials will be used to backfill the trench after the pipeline is placed. The anticipated thickness of deposition, as simulated in these analyzes, clearly demonstrate a direct relationship to suspended concentrations of sediments within the plume and to distance from the trenching operation. The orientation of the plume drift, represented in these analyzes by the relative direction of tidal currents to the axis of the pipeline, will significantly impact the location of the plume and thus the resulting deposition pattern.

Table 5
Islander East Pipeline Construction
Potential Deposited Sedimentation Layer Resulting From Turbidity Plume, cm

Sediment Release Rate From Dredge Bucket, R = 1,684 g/s

Station	Current Condition	Normal Distance From Trench Centerline, m							
		5	20	80	100	200	300	400	1000
MP 10.95	Flood	0.27	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.25	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.24	0.04	0.01	0.01	0.01	0.0	0.0	0.0
	Ebb	0.14	0.04	0.01	0.01	0.0	0.0	0.0	0.0

Sediment Release Rate From Dredge Bucket, R=445 g/s

MP 10.95	Flood	0.07	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.07	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.06	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0

Sediment Release Rate From Dredge Bucket, R=243 g/s

MP 10.95	Flood	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0
MP 11.5	Flood	0.04	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.06	0.01	0.01	0.01	0.0	0.0	0.0	0.0
MP 12.0	Flood	0.03	0.01	0.0	0.0	0.0	0.0	0.0	0.0
	Ebb	0.02	0.01	0.0	0.0	0.0	0.0	0.0	0.0

1.5 Trench Backfilling

The pipeline trench will be dredged by mechanical bucket dredge. The trench will be dredged to a depth of approximately 8' below the natural bottom and will include side slopes of 3:1, creating a trapezoidal section as shown in Figure 5 of this report. Approximately 51,180 cy of sediment will be removed from the HDD basin and pipeline trench and placed onto barges as described above. After the 24" pipeline is placed into the trench, it is anticipated that a portion of the dredged materials will be used to backfill the trench and provide 18" of cover over the pipe.

The backfilling operation will require the placement of approximately 10,000 cy of material to be dropped or transported through the water column over the basin and trench. The proponent has noted that they are "consulting with federal agencies on wether to dispose of the dredged materials offsite and/or return the material to the trench". It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to approximately 41,180 cy, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

As depicted in Figure 5, approximately 22% of the material removed from the trench will be used for backfilling and pipeline cover. More than 41,000 cy of dredged materials will have to be disposed as a result of this proposed operation. Islander East Pipeline Company, LLC has not identified the ultimate disposition or use of the materials remaining from the dredging operations. The methodology or Best Management Practices (BMP's) to be employed by Islander East Pipeline Company, LLC during the backfilling operations have not been identified. The effects of the potentially significant turbidity and material deposition within sensitive benthic communities which could result from the backfilling operations have not been identified by Islander East.

It is reasonable to conclude that the basin and trench backfilling operations could result in elevated suspended sediment levels at least equivalent to those which have been demonstrated to characterize the dredging operations. The potential impacts of the dredging, as summarized in Tables 4 and 5 of this report, could be effectively doubled by the backfilling.

2.0 Dredged Material Management

The original pipeline construction operations included the proposed sidecasting of the dredged sediments into mounds, placed along the perimeter of the transition basin and pipeline trench. These mounds were expected to extend between 10' and 11' above the natural bottom. The crests of these mounds would be positioned between 2' and 10' below the water surface during periods of low tide. It was evident that these mounds, in addition to presenting severe restrictions and significant hazards to local navigation, would be exposed to erosion processes imposed by wind generated waves which characterize this site. Sediments placed into these mounds and suspended by waves, would enter the water column and be transported from the site by tidal currents and related mechanisms.

As a result of the obvious potential environmental impacts imposed upon the surrounding benthic resources, Islander East Pipeline Company, LLC revised this proposed dredged material management method to that described in their "Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications, (OLISP) Permit #200200761" and dated March 14, 2003 (Islander East Pipeline Company, LLC, Ref. 2). The modified method is to include placement of the dredged materials on barges. The modified methodology notes that they propose to backfill the trench after placement of the pipeline to a depth 18" over the placed pipe. Figure 5 provides a graphic representation of the typical trench section. No further clarification of the methodology is provided in the permit modification document. The ultimate fate of a significant volume of the material removed from the basin and trench, i.e. in fact approximately 78% of the material to be dredged, has not be identified. The proponent has noted that they are "consulting with federal agencies on wether to dispose of the dredged materials offsite and/or return the material to the trench". It can be estimated that approximately 10,000 cy of the dredged materials will be used for backfilling of the trench. That material will have to be placed by mechanical dredge or dumped from the barges on which the material is proposed to be stored.

It can be assumed that Islander East Pipeline Company, LLC will seek further modification of the permit to relocate those dredged materials not used in backfilling the trench, amounting to more than 41,000 cy, to the open water disposal sites in Long Island Sound and that all necessary, required and currently valid mechanical, chemical, and biological characteristics will be quantified prior to issuance of any dredging authorization by both Federal and State of Connecticut regulatory agencies.

2.1 Background

The processes involved in the resuspension and transport of bottom sediments in shallow marine environments are highly complex and difficult to describe because each of the key mechanisms involving water movement and water-sediment interaction are, in themselves, complex. Weggel (Ref. 11) notes that suspended sediments are generally smaller than materials transported near the bottom. Weggel concludes that, regardless of the mode of transport, several prerequisites for net sediment movement can be identified. These include: (1) a source of movable sediment must be available; (2) a mechanism for initiating sediment movement is required; and (3) an asymmetry in the sediment motion must be present. Each of these prerequisites is present at the Islander east site.

The dredged material mounds would have provided a ready source of movable sediment. While the bottom materials appear to show plastic characteristics associated with cohesive sediments, the materials would be significantly disturbed during dredging resulting in higher water content than found in the in-situ state, thus more readily movable. The shallow bathymetry along the entire dredging route can be significantly influenced by wind generated shallow water waves. These waves, particularly those associated with storm events, would provide more than adequate energy to re-suspend and lift the dredged sediments off the mounds. Once suspended by the generally symmetrical flow regime associated with passing waves, net transport of these sediments suspended from the mounds would be a function of the tidal currents which characterize the area.

The U.S. Army Corps of Engineers (Douglass, et al., Ref. 12) acknowledges the ability of currents and waves to resuspend and transport sediments which have been placed on the ocean bottom during underwater placement operations associated with dredging projects. The U.S. Army Corps of Engineers' studies involved the monitoring of several submerged mounds or berms of generally non-cohesive dredged materials placed on the bottom of Mobile Bay. It was noted that faster peak speed of water particles under wave crests appears to be the dominant mechanism which moved these submerged berms.

2.2 Assessment of Potential Sediment Mound Erosion

It is clear that dredged material mounds, originally proposed to be placed adjacent to the transition basin and trench as a part of the Islander East pipeline construction work, could be subject to resuspension and transport via mechanisms which are typical of the site. The site is subject to storm events, most typically associated with hurricanes and nor'easter's which impact the region. These meteorological conditions typically generate wind waves originating over the open water fetches to the south and southwest of the Thimble Islands. Storm wave conditions, which can be expected at this site are summarized in Table 6. These wave characteristics were computed using the Sverdrup-Munk-Bretschneider (SMB) empirical approximation for shallow water waves as detailed on the computation sheets provided in Appendix B. The potential wave conditions were developed for a range of wind conditions which can be experienced over Long Island Sound. These conditions represent the 100-Year recurrence interval (1% chance of annual exceedence), the 50-Year recurrence interval (2% chance of annual exceedence), and the 2-Year recurrence interval (50% chance of annual exceedence).

Table 6
Characteristic Storm Wave Conditions Effecting the Project Site

Recurrence Interval	Wind Speed (mph)	South Fetch			Southwest Fetch		
		Fetch Length (mi)	Wave Characteristics		Fetch Length (mi)	Wave Characteristics	
			H_S (ft)	T (sec)		H_S (ft)	T (sec)
100-Yr	100	20.4	20.0	8.0	54.0	24.5	10.0
50-Yr	90		17.8	7.6		22.0	9.6
2-Yr	50		9.4	6.0		12.9	7.5

These wave characteristics represent the deepwater conditions of the significant wave, i.e the average of the highest 1/3 of the waves that would be generated by the representative wind blowing over the indicated fetch distance for a duration sufficient to fully develop the wave set. The required duration for the tabulated waves ranged between 2.4 hours and 6 hours. The water depths at the project site range between approximately 10' and 20', referenced to local mean low water. Water surface elevations can vary with tidal stage and coastal flooding conditions throughout Long Island Sound, but the relatively shallow conditions along the entire trench route will likely lead to breaking wave conditions, thus introducing sediment transport mechanisms similar to those on a beach face.

Table 7
Wave Induced Near-Bottom Horizontal Velocities at Dredge Mound Locations, ft/s

Recurrence Interval	Maximum Anticipated Bottom Velocities, ft/s		
	MP 10.9	MP 11.5	MP 12.0
100-Yr	12.3	13.8	13.9
50-Yr	12.3	13.7	12.3
2-Yr	9.2	7.9	6.8

Note 1: To convert ft/s to cm/s multiply ft/s by 30.48. Example - 6.8 ft/s x 30.48 = 207.3 cm/s or 2.07 m/s.

As noted from the literature citations, the primary mechanism for resuspending sediments from the proposed sediment mounds would be the movement of water induced by the passage of waves over the site. As waves translate past a position on the shallow ocean bottom, the water particles within the water column beneath the wave, will move in an orbital motion. Each water particle will assume a vertical and horizontal displacement. The size of the orbital motion and velocity of the vertical and horizontal water movement is dependent upon the wave height and period and upon the depth of water. Table 7 provides a summary of potential near-bottom wave orbital velocities which would be associated with the possible storm wave conditions at the project site.

Figure 6, provided in Appendix A, is a summary of empirical observations of sediment movement under wave action. This data clearly demonstrates that fine sediments, similar to those originally proposed to be placed in the mounds would likely be moved by water velocities exceeding 10 cm/sec. The potential near-bottom wave orbital velocities which can be realized at these sites during storms can be an order-of-magnitude greater than the threshold velocities for sediment motion. Disregarding the effects of waves breaking on the mounds, an evaluation of these near-bottom velocities revealed that the magnitude of these velocities would be sufficient to mobilize all of the materials that would have been placed in the sidecast mounds. The total volume of sediments which could be resuspended from the mounds would be dependent upon the duration of the wave impacts upon the site and upon the depth of the boundary motion at the water-sediment interface. However, the relatively significant turbulence which will be associated with storm wave passage in combination with the high orbital velocities would dislodge and transport sediments from these sites.

Sediment particles would be resuspended and transported from the mound position with the passing of each wave. The maximum anticipated period of a storm generated surface wave at the construction sites was demonstrated to be 10 seconds. It can be estimated that horizontal velocities of sufficient magnitude to mobilize the sediments will occur over approximately one-half of the wave period. It is therefore reasonable to argue that conditions favorable for erosion of the sediment mounds could persist for at least one-half of the time that the storm waves influence the site. A storm of 6-hour duration could potentially erode the entire mound system and place those materials into suspension. The mobilized sediments would be transported into adjacent waters and sensitive benthic habitat.

2.3 Dredged Material Management Alternatives

The modified construction methods, proposed by Islander East Pipeline Company, LLC, will require the disposition of more than 51,000 cy of materials removed from the HDD basin and pipeline trench. The five (5) general alternatives include:

Placement of the excavated sediments into the basin and trench to provide cover for the pipe and to restore the bottom to near pre-construction grade;

Placement of approximately 10,000 cy of the dredged sediments into the trench as cover for the pipeline and disposal of the remaining 41,000 cy of dredged materials at an upland disposal facility;

Placement of approximately 10,000 cy of the dredged sediments into the trench as cover for the pipeline and disposal of the remaining 41,000 cy of dredged materials at the Open Water Dredged Material Disposal sites in Long Island Sound;

Placement of approximately 10,000 cy of engineered backfill into the trench as cover for the pipeline and disposal of the 51,000 cy of dredged materials at an upland disposal facility; or

Placement of approximately 10,000 cy of engineered backfill into the trench as cover for the pipeline and disposal of the 51,000 cy of dredged materials at the Open Water Dredged Material Disposal sites in Long Island Sound.

As noted in previous sections of this report, placement of the dredged materials back into the basin and trench will expose the Thimble Island region to elevated turbidity levels and potential deposition of mobilized sediments onto sensitive benthic habitat areas. The magnitude of the impacts can be based upon the general results of the dredging impact assessment.

Open water disposal of dredged materials is regulated by both the U.S. Army Corps of Engineers and the State of Connecticut, Department of Environmental Protection, Office of Long Island Sound Programs (OLISP). Open water disposal of more than 25,000 cy of dredged materials requires compliance with the Federal Marine Protection, Research and Sanctuaries Act (Ambro amendment). It is essential that all reviewing agencies, including but not limited to the U.S. Environmental Protection Agency, U.S. Fish & Wildlife, and others, review the specific dredging and dredged material disposal plan proposed by Islander East Pipeline Company, LLC. It is essential that all required and currently valid mechanical, chemical, and biological characteristics of the dredged materials be quantified prior to issuance of any dredging authorization by the Federal and State of Connecticut regulatory agencies.

3.0 Summary and Conclusions

It was demonstrated that turbidity levels and sediment deposition, resulting from the proposed construction of the Islander East Pipeline Company, LLC natural gas pipeline, will potentially and significantly impact the adjacent waters of Long Island Sound. The anticipated turbidity levels and deposition will be highly dependent upon the rate of initial sediment release at the dredging position. Empirical values of sediment release rates for comparable observed dredging operations were employed to develop limits of potential suspended sediment plumes which could result from the pipeline construction operations in the vicinity of MP 10. 9 to MP 12.0. Suspended sediments could extend as far as 1000 meters from the centerline of the proposed pipeline trench and impact an area of as much as 1,700 Acres in the vicinity of the Thimble Islands in Long Island Sound. It is significant to note that the construction operations proposed by Islander East will involve, not just the initial construction dredging of the basin and trench, but will require the backfilling of the open trench to provide cover for the installed pipe. The impacts of the dredging quantified in the text will be effectively doubled. Sediments transported by local tidal flows away from the construction site will be deposited on the bottom areas adjacent to the trench.

The original proposed construction work included placing the materials dredged from the HDD transition basin and the pipeline trench into mounds adjacent to the areas of excavation. This construction methodology has been modified. Islander East Pipeline Company, LLC currently proposes to store those dredged materials on barges and either use them as cover over the installed pipeline or dispose of them in the open water disposal sites in Long Island Sound or at upland offsite facilities.

The disposition of the dredged materials have not be completely described by the Islander East Pipeline Company, LLC. It is anticipated that between 41,000 and 51,000 cy of the materials dredged from the HDD basin and pipeline trench could be disposed at the open water disposal facilities in Long Island Sound. It is essential that these materials be sufficiently characterized, including biological assessments, in accordance with the letter and intent of the Federal Marine Protection, Research and Sanctuaries Act.

It is essential that the potential impacts upon pelagic, demersal and benthic fauna as well as subtidal flora imposed by the sedimentation processes be evaluated and quantified. Mitigation measures and operational constraints should be considered by regulatory authorities to minimize potential impacts. Similar dredging and construction operations have included a range of effective measures, including but not limited to:

> Restricted temporal windows for operations to assure minimizing impacts upon potentially effected fauna and flora, including restriction of operations during the spawning periods of species indigenous to the project area;
>
> Prohibition of stockpiling or sidecasting of dredged materials, requiring temporary storage of those materials on sealed floating barges;
>
> Implementation of sealed dredge buckets to minimize re-entrainment and release of sediments into the water column during hauling operations;
>
> Environmental sensitivity training for all dredge operators to assure knowledge of means and methods to minimize sediment release into the wqater column during dredging;
>
> Imposing operational limits for sediment plume release size and concentration upon the dredging contractor and require termination of the dredging should those limits be exceeded;
>
> Requiring "third-party oversight" of all operations and monitoring and assigning authorization to that entity to shut down the operations should operational limits be exceeded;
>
> Requiring the dredging contractor to prepare and implement a ***Construction Mitigation Plan***, clearly defining all of the means and methods which he proposes to employ to minimize construction impacts.
>
> Imposing strict ***Best Management Practices*** upon the trench backfilling operations by requiring sediment plume size to be limited, imposing placement methodology restrictions, and related restrictions.

4.0 References

(1) Islander East Pipeline Company, LLC, et. al, "Islander east Pipeline Project, *Draft Environmental Impact Statement*," Federal Energy Regulatory Commission (FERC), FERC/EIS-01430, March 2002.

(2) Islander east Pipeline Company, LLC, et. al, "Islander east Pipeline Project, Amendment to the Structures, Dredging and Fill Permit Application - Construction Installation Modifications," Permit #200200761, March 14, 2003.

(3) Teeter, A. M., "New Bedford Harbor Superfund Project, Acushnet River Estuary, Engineering Feasibility Study of Dredging and Dredged Material Disposal Alternatives, Report 2, Sediment and Containment Hydraulic Transport Investigations", Technical Report EL-88-15, US Army Engineer Waterways Experiment Station, Vicksburg, MS, 1988.

(4) Bohlen, W. F., "An Investigation of Sedimentation Induced By Gas Pipeline Laying Operations In the Vicinity of the Oyster Bed Lease Areas, Milford, CT", Report Prepared for Iroquois Gas Transmission System by University of Connecticut, Department of Marine Sciences, Avery Point, Groton, CT, March 1992.

(5) Bohlen, W. F., "Factors Governing the Distribution of Dredge-Resuspended Sediments", Proceedings of the 16th Coastal Engineering Conference, American Society of Civil Engineers, Hamburg, Germany, p. 20001-2018, August 1978.

(6) Zappi, P. A. and D. F. Hayes, "Innovative Technologies for Dredging Contaminated Sediments", Misc. Paper EL-91-20, IOMT Research Program, Department of the Army, Waterways Experiment Station, Vicksburg, MS, September 1991.

(7) Collins, M. A., "Dredging Induced Near-Field Resuspended Sediment Concentrations and Source Strengths", Misc. Paper D-95-2, DOTS Program, US Army Engineer Waterways Experiment Station, Vicksburg, MS, August 1995.

(8) Vanoni, V. A. (ed), Sedimentation Engineering, American Society of Civil Engineers, New York, NY, p. 101-103, 1975.

(9) Bohlen, W.F., M.M. Howard-Strobel and M.L. Thatcher, "An Initial Evaluation of Marine Sediment Dispersion Associated with the Installation of the Islander East Natural Gas Pipeline",Prepared for Natural Resources Group, Inc., Mystic, CT, April 8, 2002.

Simpson, J. E., Gravity Currents in the Environment and the Laboratory, 2nd ed., Cambridge University Press, Cambridge, U.K., p. 140-221, 1997.

Weggel, J. Richard, " An Introduction to Oceanic Water Motions and Their Relation to Sediment Transport", Chap. 1: Water Motion and Process of Sediment Transport from *Shelf Sediment Transport*, ed. by Swift, Duane and Pilkey, Dowden, Hutchinson & Ross, Inc., Stroudsburg, PA, 1972.

Appendix A Figures 1 – 5

This document involves pipeline location information and is not available at this Internet site due to homeland security-related considerations. This portion of the Millennium Pipeline consistency appeal administrative record may be reviewed at NOAA's Office of General Counsel for Ocean Services, 1305 East-West Highway, Silver Spring, Maryland.

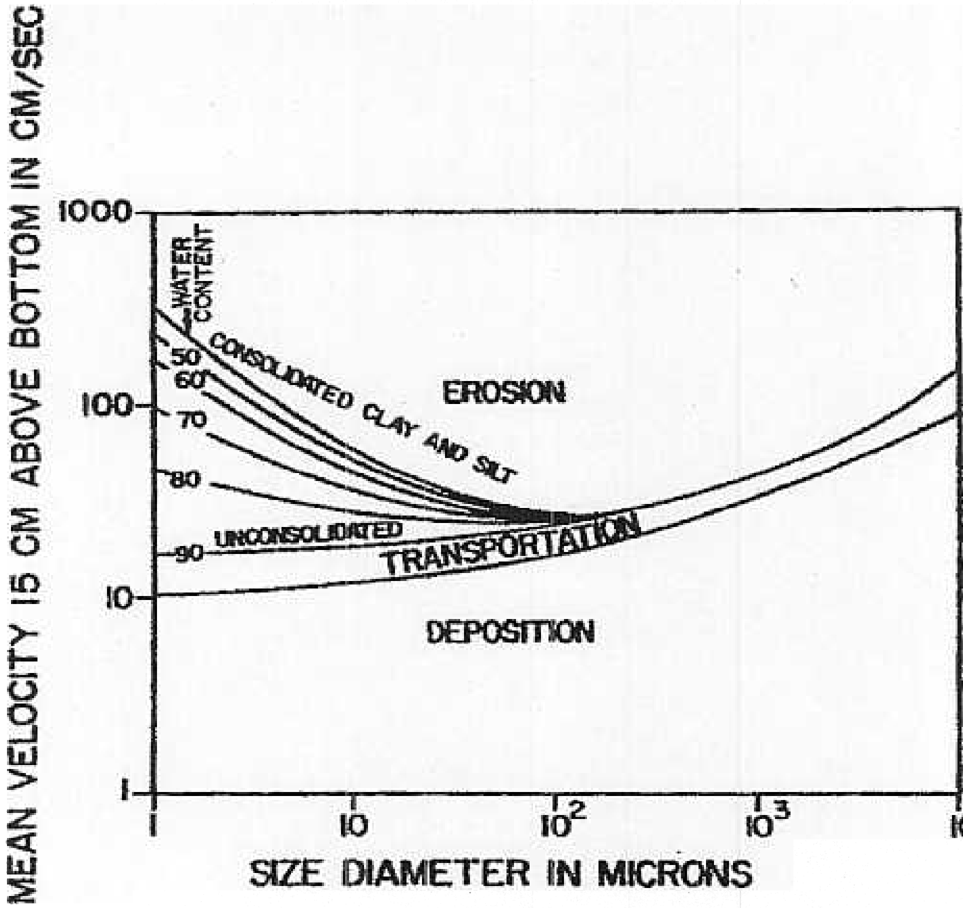

Figure 6 - Critical Erosion Characteristics for Sediments (Bohlen, Ref. 10)

Original Publication:

Basco, D.R., Bouma, A.H., and Dunlap, W.H.., "Assessment of the Factors Controling the Long-Term Fate of Dredged Material Deposited in Unconfined Subaqueous Disposal Areas, Dredged Material Research Program," Report D-074-8, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, 1974.

APPENDIX B

COMPUTATIONAL MODEL DATA

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	ISLANDER EAST PIPELINE	Sheet No.	1 of		
		Job No.	Branford 200242		
Subject:	Construction Methods Assessment	Made By:	Roberge	Date	
	Sediment Dispersion Simulation	Chkd. By:		Date	

PIPELINE STATION: MP 10.9 — Ebb Flow Condition — R= 1,684 g/s — Case 1

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood 4.00	0.57	671	168	42	34	17	11	8	3
Ebb 6.00	0.72	354	89	22	18	9	6	4	2
Average 5.00	0.66	464	116	29	23	12	8	6	2

Trenching Sediment Release Rate, R: 1684 g/s — **Current Angle:** 82

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{C\,(mg/L) \times \text{Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood	0.27	0.04	0.01	0.01	0.01	0.00	0.00	0.00
Ebb	0.14	0.04	0.01	0.01	0.00	0.00	0.00	0.00

Rev. No.
Made By — Date

JOHN C. ROBERGE, P.E., LLC

Project:	ISLANDER EAST PIPELINE	Sheet No.	1 of		
		Job No.	Branford 200242		
Subject:	Construction Methods Assessment	Made By:	Roberge	Date	
	Sediment Dispersion Simulation	Chkd. By:		Date	

PIPELINE STATION: MP 11.5 Flood Flow Condition R = 243 g/s Case 12

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	5	20	80	100	200	300	400	1000
		Distance From Trenching Operation, m							
Flood									
5.10	0.57	76	19	5	4	2	1	1	0
Ebb									
7.10	0.72	43	11	3	2	1	1	1	0
Average									
6.10	0.66	55	14	3	3	1	1	1	0

Trenching Sediment Release Rate, R: 243 g/s Current Angle: 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - **Production will be approximately** 44 LF/hr. Possible that thetrench will advance 270 LF during each **Flood and Ebb tidal cycle.**

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material coud settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{C\ (mg/L) \times \text{Depth}\ (m)}{\text{Bulk Density}\ (10000)}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	5	20	80	100	200	300	400	1000
	Distance From Trenching Operation, m							
Flood	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By Date

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: MP 12.0 Ebb Flow Condition R = 1,684 g/s Case 13

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood 6.40	0.57	420	105	26	21	10	7	5	2
Ebb 8.40	0.72	253	63	16	13	6	4	3	1
Average 7.40	0.66	313	78	20	16	8	5	4	2

Trenching Sediment Release Rate, R: 1684 g/s **Current Angle:** 82

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all **of the suspended** material coud settle at that position. Thickness of the settled material is directly **related to** plume concentration.

Thickness (cm) = $\frac{C\ (mg/L) \times Depth\ (m)}{Bulk\ Density\ (10000)}$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood	0.24	0.04	0.01	0.01	0.01	0.00	0.00	0.00
Ebb	0.14	0.04	0.01	0.01	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: **MP 12.0** Ebb Flow Condition **R = 445 g/s** **Case 14**

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m							
		5	20	80	100	200	300	400	1000
Flood 6.40	0.57	111	28	7	6	3	2	1	1
Ebb 8.40	0.72	67	17	4	3	2	1	1	0
Average 7.40	0.66	83	21	5	4	2	1	1	0

Trenching Sediment Release Rate, R: 445 g/s Current Angle: 82

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{\text{C (mg/L)} \times \text{Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m							
	5	20	80	100	200	300	400	1000
Flood	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of	
		Job No.	Branford 200242	
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge	Date
	Sediment Dispersion Simulation	**Chkd. By:**		Date

PIPELINE STATION: **MP 12.0** Ebb Flow Condition R = 243 g/s **Case 15**

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood 6.40	0.57	61	15	4	3	2	1	1	0
Ebb 8.40	0.72	37	9	2	2	1	1	0	0
Average 7.40	0.66	45	11	3	2	1	1	1	0

Trenching Sediment Release Rate, R: 243 g/s Current Angle: 82

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

Thickness (cm) = $\frac{\text{C (mg/L) x Depth (m)}}{\text{Bulk Density (10000)}}$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By Date

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: MP 12.0 Flood Flow Condition R = 1,684 g/s Case 16

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood									
6.40	0.57	420	105	26	21	10	7	5	2
Ebb									
8.40	0.72	253	63	16	13	6	4	3	1
Average									
7.40	0.66	313	78	20	16	8	5	4	2

Trenching Sediment Release Rate, R: 1684 g/s Current Angle: 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material coud settle at that position. Thickness of the settled material is directly related to plume concentration.

Thickness (cm) = $\frac{\text{C (mg/l) x Depth (m)}}{\text{Bulk Density (10000)}}$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood	0.24	0.04	0.01	0.01	0.01	0.00	0.00	0.00
Ebb	0.14	0.04	0.01	0.01	0.00	0.00	0.00	0.00

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Made By Date

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: MP 12.0 Flood Flow Condition R = 445 g/s Case 17

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood									
6.40	0.57	111	28	7	6	3	2	1	1
Ebb									
8.40	0.72	67	17	4	3	2	1	1	0
Average									
7.40	0.66	83	21	5	4	2	1	1	0

Trenching Sediment Release Rate, R: 445 g/s **Current Angle:** 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{\text{C (mg/L) x Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: **MP 12.0** Flood Flow Condition R = 243 g/s **Case 18**

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood									
6.40	0.57	61	15	4	3	2	1	1	0
Ebb									
8.40	0.72	37	9	2	2	1	1	0	0
Average									
7.40	0.66	45	11	3	2	1	1	1	0

Trenching Sediment Release Rate, R: 243 g/s Current Angle: 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{\text{C (mg/L) x Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
Location:	Branford, CT - Long Island Sound	**Job No.**	200242		
Subject:	SMB Hindcast Model with Shallow	**Made By**	Roberge	**Date**	11/26/2002
	Water Correction - 100 Yr Wind / 100 Yr Deptl	**Chkd. By**		**Date**	

Constants

		Units	
Gravity, g	9.81	m/s^2	
Surface Wind, Us	100.0	mi/hr	Ref: Handbook of Ocean and Underwater Engineerin
	44.7	m/s	Myers, Holm, McAllister, ed, McGraw-Hill, 1969, p.8-5
Wind Stress Factor, Ua	76.1	m/s	$U_A = 0.71 U_S^{1.23}$

Variables

	Units	Reach #1	Reach #2
Wind Direction		South	SW
Fetch Distance, F	n.mi	20.4	54.0
	m	37780.8	100008.0
Average Water Depth,	ft	88.0	82.0
	m	26.8	25.0

Calculations

	Units	Reach #1	Reach #2
Wave Height, H	m	6.1	7.5
	ft	20.0	24.5

$$H = \frac{.283 U_A^2}{g} \tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right] \tanh\left[\frac{.00565\left(\frac{gF}{U_A^2}\right)^{1/2}}{\tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right]}\right]$$

	Units	Reach #1	Reach #2
Wave Period, T	sec	8.0	10.0

$$T = \frac{7.54 U_A}{g} \tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right] \tanh\left[\frac{.0379\left(\frac{gF}{U_A^2}\right)^{1/3}}{\tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right]}\right]$$

	Units	Reach #1	Reach #2
Duration, t	hrs	2.4	4.5

$$t = 8.93 \times 10^{-1}\left(\frac{F^2}{U_A}\right)^{1/3}$$

Rev. No.	
Made By	**Date**

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	2	of	
Location:	Branford, CT - Long Island Sound	**Job No.**	200242		
Subject:	SMB Hindcast Model with Shallow Water Correction - 50 Yr Wind / 50 Yr Depth	**Made By**	Roberge	**Date**	11/26/2002
		Chkd. By		**Date**	

Constants

		Units	
Gravity, g	9.81	m/s^2	
Surface Wind, Us	90.0	mi/hr	Ref: Handbook of Ocean and Underwater Engineerin
	40.2	m/s	Myers, Holm, McAllister, ed, McGraw-Hill, 1969, p.8-5
Wind Stress Factor, Ua	66.8	m/s	$U_A = 0.71 U_S^{1.23}$

Variables

	Units	Reach #1	Reach #2
Wind Direction		South	SW
Fetch Distance, F	n.mi	20.4	54.0
	m	37780.8	100008.0
Average Water Depth,	ft	85.0	79.0
	m	25.9	24.1

Calculations

	Units	Reach #1	Reach #2
Wave Height, H	m	5.4	6.7
	ft	17.8	22.0

$$H = \frac{.283 U_A^2}{g} \tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right] \tanh\left[\frac{.00565\left(\frac{gF}{U_A^2}\right)^{1/2}}{\tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right]}\right]$$

	Units	Reach #1	Reach #2
Wave Period, T	sec	7.6	9.6

$$T = \frac{7.54 U_A}{g} \tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right] \tanh\left[\frac{.0379\left(\frac{gF}{U_A^2}\right)^{1/3}}{\tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right]}\right]$$

	Units	Reach #1	Reach #2
Duration, t	hrs	2.5	4.7

$$t = 8.93 \times 10^{-1}\left(\frac{F^2}{U_A}\right)^{1/3}$$

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Made By	**Date**

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	3	**of**	
Location:	Branford, CT - Long Island Sound	**Job No.**	200242		
Subject:	SMB Hindcast Model with Shallow Water Correction - 2 Yr Wind / 2 Yr Depth	**Made By**	Roberge	**Date**	11/26/2002
		Chkd. By		**Date**	

Constants

		Units	
Gravity, g	9.81	m/s^2	
Surface Wind, Us	50.0	mi/hr	Ref: Handbook of Ocean and Underwater Engineerin
	22.4	m/s	Myers, Holm, McAllister, ed, McGraw-Hill, 1969, p.8-5
Wind Stress Factor, Ua	32.4	m/s	$U_A = 0.71 U_S^{1.23}$

Variables

	Units	Reach #1	Reach #2
Wind Direction		South	SW
Fetch Distance, F	n.mi	20.4	54.0
	m	37780.8	100008.0
Average Water Depth,	ft	82.0	77.0
	m	25.0	23.5

Calculations

	Units	Reach #1	Reach #2
Wave Height, H	m	2.9	3.9
	ft	9.4	12.9

$$H = \frac{.283 U_A^2}{g} \tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right] \tanh\left[\frac{.00565\left(\frac{gF}{U_A^2}\right)^{1/2}}{\tanh\left[.530\left(\frac{gd}{U_A^2}\right)^{3/4}\right]}\right]$$

	Units	Reach #1	Reach #2
Wave Period, T	sec	6.0	7.5

$$T = \frac{7.54 U_A}{g} \tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right] \tanh\left[\frac{.0379\left(\frac{gF}{U_A^2}\right)^{1/3}}{\tanh\left[.833\left(\frac{gd}{U_A^2}\right)^{3/8}\right]}\right]$$

	Units	Reach #1	Reach #2
Duration, t	hrs	3.2	6.0

$$t = 8.93 \times 10^{-1}\left(\frac{F^2}{U_A}\right)^{1/3}$$

Rev. No.
Made By **Date**

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	**of**	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 10.95 - 100 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 10.95 - Water Depth = 13 ft (MLW) - Breaking Conditions (Depth Limited)
100 Yr Return Period

SITE CONDITIONS :				
	H wave =	16.6	**ft**	
	T wave =	10.0	**sec**	
	L wave =	199.0	**ft**	**(See NOTE)**
	d, depth =	13.0	**ft**	

Depth, Ft	Umax, Ft/sec
13.0	12.37
12.5	12.37
12.0	12.38
11.5	12.39
11.0	12.40
10.5	12.41
10.0	12.43
9.5	12.45
9.0	12.47
8.0	12.53
7.0	12.60
6.0	12.68
5.0	12.77
4.0	12.88
3.0	13.00
2.0	13.13
1.0	13.27
0.0	13.43

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : **d / Lo { For Design Conditions} =** **0.0254**

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.		**File Ref.: orbvel**
Made By	**Date**	

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 11.5 - 100 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 11.5 - Water Depth = 16.7 ft (MLW) - Breaking Conditions (Depth Limited)
100 Yr Return Period

SITE CONDITIONS :

H wave =	21.4	ft	
T wave =	10.0	sec	
L wave =	224.0	ft	(See NOTE)
d, depth =	16.7	ft	

Depth, Ft	Umax, Ft/sec
16.7	13.84
16.0	13.84
15.5	13.84
15.0	13.85
14.5	13.86
14.0	13.88
13.5	13.89
13.0	13.91
12.0	13.96
10.0	14.08
8.0	14.25
6.0	14.46
5.0	14.59
4.0	14.72
3.0	14.87
2.0	15.03
1.0	15.20
0.0	15.38

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0326

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.		File Ref.: orbvel
Made By	Date	

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 12.0 - 100 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 12.0 - Water Depth = 21 ft (MLW) - Non-Breaking Conditions
100 Yr Return Period

SITE CONDITIONS :

H wave =	24.5	ft	
T wave =	10.0	sec	
L wave =	248.8	ft	(See NOTE)
d, depth =	21.0	ft	

Depth, Ft	Umax, Ft/sec
21.0	13.86
20.0	13.86
18.0	13.90
16.0	13.97
14.0	14.08
12.0	14.22
11.0	14.30
10.0	14.40
9.0	14.50
8.0	14.61
7.0	14.73
6.0	14.87
5.0	15.01
4.0	15.16
3.0	15.32
2.0	15.49
1.0	15.66
0.0	15.85

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0410

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.	
Made By	**Date**

File Ref.: orbvel

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 10.95 - 50 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 10.95 - Water Depth = 13 ft (MLW) - Breaking Conditions (Depth Limited)
50 Yr Return Period

SITE CONDITIONS :

H wave =	16.6	ft	
T wave =	9.6	sec	
L wave =	191.0	ft	(See NOTE)
d, depth =	13.0	ft	

Depth, Ft	Umax, Ft/sec
13.0	12.29
12.5	12.29
12.0	12.30
11.5	12.31
11.0	12.32
10.5	12.33
10.0	12.35
9.5	12.37
9.0	12.40
8.0	12.46
7.0	12.53
6.0	12.62
5.0	12.72
4.0	12.83
3.0	12.96
2.0	13.11
1.0	13.26
0.0	13.43

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0276

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.	File Ref.: orbvel
Made By **Date**	

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 10.95 - 2 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 10.95 - Water Depth = 13 ft (MLW) - Non-Breaking Conditions
2 Yr Return Period

SITE CONDITIONS :				
	H wave =	12.9	ft	
	T wave =	7.5	sec	
	L wave =	146.0	ft	(See NOTE)
	d, depth =	13.0	ft	

Depth, Ft	Umax, Ft/sec
13.0	9.19
12.5	9.19
12.0	9.20
11.5	9.21
11.0	9.23
10.5	9.25
10.0	9.27
9.5	9.30
9.0	9.33
8.0	9.41
7.0	9.50
6.0	9.61
5.0	9.74
4.0	9.89
3.0	10.06
2.0	10.24
1.0	10.45
0.0	10.67

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0451

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.		File Ref.: orbvel
Made By	**Date**	

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	**of**	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 11.5 - 2 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 11.5 - Water Depth = 16.7 ft (MLW) - Non-Breaking Conditions
2 Yr Return Period

SITE CONDITIONS :

H wave =	12.9	ft	
T wave =	7.5	sec	
L wave =	163.0	ft	(See NOTE)
d, depth =	16.7	ft	

Depth, Ft	Umax, Ft/sec
16.7	7.87
16.0	7.87
15.5	7.88
15.0	7.89
14.5	7.90
14.0	7.91
13.5	7.93
13.0	7.95
12.0	8.00
10.0	8.13
8.0	8.32
6.0	8.55
5.0	8.68
4.0	8.83
3.0	8.99
2.0	9.17
1.0	9.35
0.0	9.56

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0580

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.		File Ref.: orbvel
Made By	**Date**	

JOHN C. ROBERGE, P.E., LLC

Project:	Islander East Pipeline Construction	**Sheet No.**	1	of	
		Job No.	200242		
Subject:	Erosion Potential of Dredge Mounds	**Made By**	Roberge	**Date**	12/05/02
	MP 12.0 - 2 Yr Return	**Chkd. By**		**Date**	

MAXIMUM WATER PARTICLE VELOCITIES BENEATH DESIGN WAVE
MP 12.0 - Water Depth = 21 ft (MLW) - Non-Breaking Conditions
2 Yr Return Period

SITE CONDITIONS :

H wave =	12.9	ft	
T wave =	7.5	sec	
L wave =	180.0	ft	(See NOTE)
d, depth =	21.0	ft	

Depth, Ft	Umax, Ft/sec
21.0	6.76
20.0	6.76
18.0	6.79
16.0	6.86
14.0	6.96
12.0	7.09
11.0	7.17
10.0	7.26
9.0	7.36
8.0	7.46
7.0	7.58
6.0	7.70
5.0	7.84
4.0	7.98
3.0	8.13
2.0	8.30
1.0	8.47
0.0	8.65

Maximum Water Particle Velocities will occur in coincidence with the passing of the wave crest and / or trough. Design must consider the relative direction of the water particle motion.

NOTE : d / Lo { For Design Conditions} = 0.0729

Wavelength at Site, L, can be determined from Tables Showing Functions of d / L for Increments of d /Lo.

Rev. No.
Made By Date

File Ref.: orbvel

File Ref. : compsht

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: **MP 11.5** **Flood Flow Condition** **R = 1,684 g/s** **Case 10**

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood									
5.10	0.57	527	132	33	26	13	9	7	3
Ebb									
7.10	0.72	299	75	19	15	7	5	4	1
Average									
6.10	0.66	380	95	24	19	10	6	5	2

Trenching Sediment Release Rate, R: 1684 g/s **Current Angle:** 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{C\text{ (mg/L) x Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m 5	20	80	100	200	300	400	1000
Flood	0.25	0.04	0.01	0.01	0.01	0.00	0.00	0.00
Ebb	0.14	0.04	0.01	0.01	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

Sediment Dispersion Simulation Chkd. By:

JOHN C. ROBERGE, P.E., LLC

Project:	**ISLANDER EAST PIPELINE**	**Sheet No.**	1 of
		Job No.	Branford 200242
Subject:	**Construction Methods Assessment**	**Made By:**	Roberge **Date**
	Sediment Dispersion Simulation	**Chkd. By:**	**Date**

PIPELINE STATION: MP 11.5 Flood Flow Condition R = 445 g/s Case 11

TURBIDITY PLUME CENTERLINE CONCENTRATION, mg/liter

Depth, m	Current m/s	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood 5.10	0.57	139	35	9	7	3	2	2	1
Ebb 7.10	0.72	79	20	5	4	2	1	1	0
Average 6.10	**0.66**	**100**	**25**	**6**	**5**	**3**	**2**	**1**	**1**

Trenching Sediment Release Rate, R: 445 g/s **Current Angle:** 265

Basin Construction and trenching MP 10.9 to MP 12.0 - Islander East Pipeline - Thimble Islands, CT

Trench excavated by Bucket Dredge,per Islander East documents. Excavation of 272 CF / LF of trench (or about 10CY/LF). Anticipate a bucket of about 10 CY capacity. Estimate cycle speed for bucket will be about 60 sec at this shallow site. The trench advance rate will be approximately 1.0 ft/min. Considering that anchors / spud repositioning every 120 LF of trench (est. length of work barge) and that repositiioning will require approx. 45 minutes - Production will be approximately 44 LF/hr. Possible that thetrench will advance 270 LF during each Flood and Ebb tidal cycle.

Deposition potential was represented by the extent of the lines of constant C assuming that all of the suspended material could settle at that position. Thickness of the settled material is directly related to plume concentration.

$$\text{Thickness (cm)} = \frac{\text{C (mg/L)} \times \text{Depth (m)}}{\text{Bulk Density (10000)}}$$

Bulk Density (g/cc) : 1.5

Deposited Sediment Layer Thickness, cm

Plume	Distance From Trenching Operation, m: 5	20	80	100	200	300	400	1000
Flood	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ebb	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Rev. No.
Made By **Date**

Report of Findings

Board of Selectmen
Town of Branford
Branford, CT 06405

Preliminary Report on the Anticipated Biological Impacts Associated with the Proposed Islander East Pipeline Project, through the Nearshore Area of Long Island Sound - Branford, CT

JN 02-006

May 8, 2003

The Garrett Group, LTD.
280 Black Cat Road
Plymouth, MA 02360
(508) 747-3553

PRELIMINARY REPORT ON THE ANTICIPATED BIOLOGICAL IMPACTS ASSOCIATED WITH THE PROPOSED ISLANDER EAST PIPELINE PROJECT, THROUGH THE NEARSHORE AREA OF LONG ISLAND SOUND - BRANFORD, CONNECTICUT

TABLE OF CONTENTS

PRELIMINARY REPORT ON THE ANTICIPATED BIOLOGICAL IMPACTS ASSOCIATED WITH THE PROPOSED ISLANDER EAST PIPELINE PROJECT, THROUGH THE NEARSHORE AREA OF LONG ISLAND SOUND - BRANFORD, CONNECTICUT

Executive Summary

The Garrett Group, LTD. (TGG) has been retained by the Town of Branford, CT (the Client) to conduct a review of technical environmental materials presented by Islander East Pipeline Company (the proponents) to various regulators for the above-referenced project. TGG accepts the biological data presented by the proponents as valid. However, a future field effort may occur and these data will be provided. TGG's evaluation is limited to the subtidal environment of the Long Island Sound (LIS) project area associated with the project's Connecticut Mainland approach, which includes the dredged Horizontal Directional Drilling (HDD) transition basin beginning at MP 10.1 and extending to MP 10.9; the mechanically dredged pipeline trench (MP 10.9 to MP 12), that extends beyond the limit of town jurisdiction; and a short portion of the seaplow trench from MP 12 to MP 12.5 out to Northwest Reef. The LIS estuary provides extensive natural and physical resources, and suitable shellfish and finfish habitats.

The pipeline project proposes to lay a 24" welded gas pipeline from Branford, CT across the central portion of LIS to Wading River, NY, on Long Island. The Connecticut Mainland approach will directly impact 440± ac of nearshore bottom. Direct Impacts include displacement or disruption from dredging, barge anchor scars and cable sweeps. The proponents proposed to side cast the dredged material into temporary piles around the perimeter of the trench, however they now propose to place dredge material on barges as opposed to side casting onto the nearshore bottom. The proponent reports that the backfilling proposal has been modified from 3.0± ft of cover over the pipeline, to 1.5± ft of cover over the pipeline. This modification creates a bowl depression of 1.5± ft over 0.75 ac and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. The change in relief should not pose any additional adverse effect to the post construction nearshore bottom.

Recolonization of bottom disturbances can vary dramatically. These periods can range from a few weeks for pioneer species to several years for late successional species, and are extremely dependent on site specific physical, environmental and anthropogenic conditions.

Indirect impacts caused by dredging and disposal operations cannot be quantified at this time, but include increased suspended solids, sedimentation and anoxic episodes. Motile species will move to avoid turbid sediment plumes, while sessile species must survive the event(s). Based on the reported ebb and flood currents for the project area, the plume will migrate to the east-northeast on the ebb current, and west on the flood current. Since the ebb current is slightly faster than the flood current, TGG would expect the extent of the plume to be slightly greater to the east-northeast than to the west. Sedimentation typically smothers benthic species and demersal/benthic eggs. Demersal eggs are subjected to abrasion from coarse sediments.

Worst-case modeled suspended solid concentrations at the Thimble Islands ≤ 3 mg/l. The sub- and intertidal rocky outcrops immediately to the west of the Thimbles are also subjected to nearly absent turbidity, with plume concentrations of 3 - 10 mg/l. Based on reported impact thresholds, it appears that sedimentation in the amounts to cause 50 - 100% mortality to demersal and benthic eggs and species could occur within, and to ≤ 100 ft of the trench footprints. Resuspension of anoxic muds and silts will likely cause an anoxic episode(s) in the overlying water column.

Should side cast storage of material re-emerge as a preferred project alternative, the proposed piles will have heights of 10 - 11 ft and will extend to between 2 - 10 ft of the water surface These piles will present temporary navigational hazards and be exposed to both ambient and storm generated wave action, breaking wave conditions, and deepwater/wave generated water velocities. These piles will likely be eroded and redistributed. The transport of these materials will likely extend to the reaches of the defined sediment plume. In the best scenario and if the piles remain in place, the backfilling of the basin and trench will cause a second plume episode of elevated suspended solids and sedimentation. In either case, the impact of erosion or of the backfilling could be as much as that of the original dredging and would cumulative.

The soft substrate in the project area includes: anoxic mud, soft mud and coarse and silty sand. Evidence of Quahaugs (*Mercenaria mercenaria*), Eastern Oysters (*Crassostrea virginica*) and Surf Clams (*Mulinia* sp.) exist throughout the nearshore project area, indicative of shellfish habitat. Various other benthic species were also evident throughout this habitat (e.g. crabs, whelks, worms and other clams). Rocky subtidal outcrops, functioning as reef-like (fouling) habitat, are interspersed among the dominant soft substrates. Fouling species include the macroalgae (Rockweeds - *Fucus* sp. and *Ascophyllum* sp., and Sea Lettuce - *Ulva* sp.), Blue Mussels (*Mytilus edulis*), Oyster Drills (*Urosalpinx cinera*), Dove Snails (*Mitrella lunata*), Red-beard Sponge (*Microcionia prolifera*), Convex Slipper Shell (*Crepidula plana*) and Slipper Shell (*C. fornacata*).

Approximately twenty-three (23) finfish species may transit or reside in the project area. Egg distribution of ten (10) of these species are laid on, or settle to the bottom. Four (4) species of *Arthropoda* are benthic or demersal species. Lobsters reside along hard bottoms or bottoms with relief and or shelter conditions. At maturity, lobster eggs are hatched when the female agitates them by shaking her body and the offspring are cast off. The young drift as pelagic zooplankton then settle as early benthic forms with a soft carapace and require stable hard substrates with relief and crevices, or with ample sheltering features until maturity.

The proposed actions will cause an estimated direct displacement or damage to 440± ac of nearshore bottom area between MP 10.1 - 12.5. These impacts will be caused by the dredging/trenching, barge anchor scars and anchor cable sweeps. The anticipated bottom damage will alter an existing productive shellfish habitat, and an existing invertebrate community structure inclusive of a late successional/transition structure to a pioneer/opportunistic structure. After all project related activities and secondary conditions associated with the construction have ceased, the bottom will recover after several years and return to the existing condition. In addition to direct bottom damage, indirect impacts caused by elevated suspended solid concentrations at or near the bottom can be irritating to any species that remains/survives within construction locus.

Mechanical clamshell dredging of medium sands with some coarse and silty fractions will generated suspended solids concentrations ranging from 50-700 mg/l, and the plume will decay rapidly. These concentrations are reported within 16.5 ft (5 m) of the centerline of the proposed dredged trench.

Measurable residual concentrations can exist along the bottom up to 3040± ft (920 m). Concentrations of suspended solids are directly related to the speed of the bucket retrieval during the dredging.

The literature reports that sedimentation deposits of 0.5 - 1.0 mm will cause up to 50%, and deposition of up to 2.0 mm will cause 100% mortality to non-encased pelagic fish eggs with diameters of up to 0.9 mm. Deposition between 1.0 - 2.0 mm will limit the settling of shellfish culch. Potentially damaging sedimentation thicknesses generated from the project can occur within 100 ft of the dredged trenches. Sedimentation can cover existing unaffected soft bottom conditions, possibly smothering existing resources; or cover limited hard substrate conditions, reducing both fouling and sheltering hard substrate conditions, and possibly smothering existing resources.

Impacts of primary concern should include the 440± ac of direct displacement or damage. These losses will have a dramatic effect in the short term fishery (commercial and recreational). In addition, secondary concern should include the various turbidity events anticipated, and the deposition of sediments on the hard substrate habitats. TGG recommends that stringent and specific construction supervision and mitigation, and compensatory resource mitigation must be developed to protect nearshore resources and compensate (in- and out of kind) for lost valuable resources.

REPORT OF FINDINGS

PRELIMINARY REPORT ON THE ANTICIPATED BIOLOGICAL IMPACTS ASSOCIATED WITH THE PROPOSED ISLANDER EAST PIPELINE PROJECT, THROUGH THE NEARSHORE AREA OF LONG ISLAND SOUND - BRANFORD, CONNECTICUT

SECTION ONE: INTRODUCTION

The Garrett Group, LTD. (TGG) has been retained by the Town of Branford, CT (the Client) to conduct a review of technical environmental materials presented by Islander East Pipeline Company (the proponents) to various regulators for the above-referenced project. Included in our review is the Final Environmental Impact Statement (FEIS)[1] and various technical reports prepared in support of, or to augment the FEIS presentation. TGG has also reviewed a study prepared for the Client, by Roberge (2003)[2]; a benthic study prepared for the proponent, by TRC (2003)[3], and various other literature resources available to TGG. TGG accepts the biological data presented by the proponents as valid. However, we have also been requested by the Client to verify the biological information presented by the proponents. Therefore, TGG will conduct field sampling during the upcoming months. Any additional findings will be presented as an addendum to this report.

TGG's evaluation is limited to the subtidal environment of the project area associated with the project's Connecticut Mainland approach, which includes the dredged Horizontal Directional Drilling (HDD) transition basin beginning at MP 10.1 and extending to MP 10.9; the mechanically dredged pipeline trench (MP 10.9 to MP 12), that extends beyond the limit of town jurisdiction; and a short portion of the seaplow trench from MP 12 to MP 12.5 out to Northwest Reef.

The FEIS accurately describes Long Island Sound (LIS) as one of the largest estuaries along the Atlantic coast of the United States. LIS is a semi-enclosed northeast-southwest trending basin that is approximately 113 mi long and 20 mi wide. Its eastern end opens to the Atlantic Ocean through several large passages between islands. The western end is connected to New York Harbor through a narrow tidal strait. According to the Eldridge Tide and Pilot Book 2003[4], ebb currents in the project area trend to the east-northeast, or 82° as reported by Roberge 2003. Flood currents trend to the west or 265°, as reported by

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1 FERC. 2002. Islander East Pipeline Project - Final Environmental Impact Statement. Islander East Co. LLC. - Docket No. CP01-384.000 and Algonquin Gas Transmission Co. - Docket No. CP01-387-000. FERC/EIS - 0143F.

2 Roberge, J.C. 2003. Potential sedimentation impacts which could result from dredging, MP 10.9 - MP 12.0 Proposed Construction of the Islander East Gas Transmission Pipeline. Prepared for the Town of Branford, CT, by John C. Roberge, PE, LLC.

3 TRC Environmental Corporation. 2003. Evaluation of Benthic Impacts Associated with Islander East's Modified Offshore Construction Techniques - Islander East Pipeline Project. Prepared for: Islander East Pipeline Company, LLC, Branford, CT. Prepared by: TRC Environmental Corporation, Lowell, MA. pp 1-7.

4 White, M.J., R.E. White, Jr. and L.F. White. 2003. Eldridge Tide and Pilot Book - 2003. Boston, MA. pgs. 78-83.

Roberge (2003). Roberge (2003) also reports that maximum current velocities on the ebb current run at 72 cm/s, and on the flood run at 57 cm/s.

The proposed pipeline will cross the central portion of LIS. The major water quality issue associated with LIS is extremely low dissolved oxygen (DO) concentrations (anoxia or hypoxia) in, or near the bottom waters. This condition is typically encountered in the western portion of LIS; however, concerns include the entire Connecticut shoreline during the summer months or during specific events throughout the year (i.e marine construction activities). LaSalle et al (1991)[5] reports that dredging or disposal induced dissolved oxygen (DO) reduction in the water column around the construction activity is a direct consequence of the suspension of anoxic sediment material causing an episodic chemical or biological oxygen demand. DO reductions of 2 - 4 mg/l can be catastrophic to the nearshore community, especially during slack water. Please review any one of the annual CTDEP-OLISP Sound Hypoxia Reports as published in hard copy or on the CTDEP web page, for both short - and long term trends.

Estuarine embayments typically provide extensive natural and physical resources, and suitable shellfish and finfish habitats. National Marine Fisheries Service (NMFS) personnel (Milford, CT) are typically concerned with adverse effects to Winter Flounder *(Pleuronectes americanus)* breeding habitat and American Lobster (*Homarus americanus*) habitat relative to dredging projects proposed for the Connecticut nearshore area.

SECTION TWO: PROPOSED PROJECT ACTIVITIES AND ANTICIPATED EFFECTS WITHIN THE STUDY AREA

Nearshore Bottom Involvement

The pipeline project proposes to lay a 24" welded gas pipeline from Branford, CT across the central portion of LIS to Wading River, NY, on Long Island.

The Connecticut Mainland approach includes a transition from a subsurface onshore to subsurface offshore pipeline. The passing from the onshore to offshore portion of the pipeline will be constructed using the HDD method. A borehole will be set below the sea floor at the Tilcon Crossing Channel. The HDD portion of the pipeline will extend 0.60 mi into the nearshore area of LIS to MP 10.9. At this location, the pipeline alignment will transition to a mechanically dredged channel. The dredged channel will continue offshore for an additional 1.1 mi from MP 10.9 to MP 12. At MP 12, the pipeline will lay in a plow trench using a seaplow methodology.

The HDD borehole will be a subsurface feature and will have no direct effect on the nearshore sea floor. The borehole will be drilled from a land-based drilling platform on the Connecticut Mainland. To assist the drill over the 0.60 mi length of proposed borehole, the borehole will be lubricated using a bentonite slurry that will be pumped into the borehole as the drill advances. The slurry will be mixed on, and be pumped from the land-based drilling platform. The borehole will pierce the sidewall (landside) of the HDD

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5 LaSalle, M.W., D.G. Clarke, J. Homziak, J.D. Lunz and T.J. Fredette. 1991. *"A Framework for Assessing the Need for Seasonal Restrictions on Dredging and Disposal Operations"*. Tech Rep D-91-1, US Army Engineer Waterways Exp Stn, Vicksburg, MS.

transition trench. The dimensions of this trench are 250' long by 130' wide (32,500 sf or 0.75 ac), and approximately 20' deep. This surface area allows for working room to insert the 24" welded pipeline into the borehole. The welded pipe will be pulled back through the borehole as the drill is extracted back toward land. The 250' trench length also allows for the pipe's elevation transition from the deep borehole to the shallow dredge trench (5' ft below the seabed). Anchored surface and lay barges will provide over water working and storage platforms to fabricate and lay the welded pipeline. The dredging of the transition trench will generate approximately 6500 cy of material.

In their initial submittals, the proponents proposed to side cast the dredged material into temporary piles around the perimeter of the trench. The toe width of the side cast piles is 65± ft. Side casting of trench material would add 49,400 sf or 1.13 ac of surface area impact[6]. A later submittal (TRC 2003) indicates that the proponents propose to place dredge material on barges as opposed to side casting onto the nearshore bottom, therefore eliminating the predicted 1.13 ac of temporary bottom displacement. The dredged transition trench will be backfilled with a portion of the dredge material stored on the barges, or engineered fill (cut stone and/or graded sand) barged out to the site, to cover the laid pipeline with 1.5' of cover material.

Since there will be several barging events (e.g. dredging, pipeline construction and backfilling), anticipated surface area disruption from anchor scars and anchor cable sweeps will occur during each event, and will overlay each other. Based on numbers reported in the FEIS, TGG estimates surface area impacts (temporary disruptions) from both anchor scars and anchor cable sweeps to be up to 18 ac in association with the HDD construction method[7].

Previously, the mechanical dredge trench construction included side casting of dredge material. However, the proponent now proposes to place the dredge material from the trench between MP - 10.9 and 12 (1.1 mi) on barges, causing 6.67 ac of disruption to the nearshore bottom[8]. This reduces direct bootom displacement by 8.0± ac. The dredging of the dredge trench will generate approximately 45,000 cy of material. As with the transition trench dredging, the dredged trench will be backfilled with a portion of the dredge material stored on the barges, or engineered fill barged out to the site, to cover the laid pipeline with 1.5' of cover material. Anticipated surface area disruption from barge anchor scars and anchor cable sweeps will occur during each event, will overlay each other, and are estimated to be up to 280 ac in association with the mechanical dredge trench[9].

From MP 12 to where the depth of LIS is < 20' along the nearshore area of Long Island, the pipeline will be laid in a proposed seaplow trench. The seaplow trench and spoil mounds will temporarily displace 4.5± ac

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6 ([250' x 65'] x 2) + ([130' x 65'] x2) = 49,400 sf / 43560 sf / ac = 1.13 ac.

7 The FEIS appears to have calculated impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 0.07 mi project distance.

8 (5280'/mi x mi) x 50' = 290,400 sf / 43560 sf / ac = 6.67 ac.

9 The FEIS appears to have calculated these impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 1.1 mi project distance.

of nearshore bottom[10] between MP 12 and MP 12.5. Anticipated surface area impacts from both anchor scars and anchor cable sweeps are estimated to be up to 130 ac in association with the short run of the seaplow trench (MP 12 - 12.5)[11].

Table 1 presents a summary of TGG's estimated direct surface area displacement or effects to the Connecticut nearshore bottom area of LIS.

TABLE 1: ANTICIPATED SURFACE AREA EFFECTED IN THE BRANFORD, CT NEARSHORE BOTTOM (MP 10.1 - 12.5)

Construction Operations		Location	Effected Surface Area	
Method	Action		Square Footage	Acreage
HDD	Borehole	MP 10.1 - 10.9	N/A	N/A
	Transition Trench		32,500±	0.75
	Anchor Scars & Cable Sweeps		784,100±	18
Dredge Trench	Dredged Trench	MP 10.9 - 12	290,400±	6.67
	Anchor Scars & Cable Sweeps		1.2×10^7±	up to 280±
Sea Plow	Trench & Side Cast Piles	MP 12 - 12.5	196,000±	4.5
	Anchor Scars & Cable Sweeps		5.7×10^6±	up to 130±
ESTIMATED TOTAL SURFACE AREA EFFECTED				440± ac

The proponent's impact estimates for both the transition trench and dredge trench do not appear to take into account the anchor scars or cable sweeps as bottom impacts. In TGG's best professional judgement, anchor scars and cable sweeps change bottom relief, and disrupt bottom conditions. While these impacted areas will recolonize, there will be a short-termed adverse effects and therefore should be part of the direct impact calculation.

For the transition trench, the FEIS reports direct bottom impacts to be 24± ac including side cast piles; and TRC (2003) reports impacts to be 8± ac without side cast piles. For the dredge trench, the FEIS reports direct bottom impacts to be 115± ac including side cast piles; and TRC (2003) reports impacts to be 5.6± ac without side cast piles.

10 75' x 2640' / ½ mi = 198,000 sf / 43560 sf / ac = 4.5 ac

11 The FEIS appears to have calculated these impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 0.5 mi project distance.

TRC (2003) also reports that the backfilling proposal has been modified from 3.0± ft of cover over the pipeline, to 1.5± ft of cover over the pipeline. This modification reduces the direct surface area impacts as reported by TRC (2003). It also creates a bowl depression of 1.5± ft over 0.75 ac of the bottom, and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. The change in relief should not pose any additional adverse effect to the post construction nearshore bottom.

Dredging is proposed to create the HDD transition trench and the dredging trench. Environmental concerns relative to dredging include: temporary loss of existing benthic habitat; increased suspended solids; resuspension of sediment bound pollutants; anoxic episodes, and sedimentation. During the dredging, the benthic habitat will undergo disturbance, and may eventually recover at the completion of the project. Based on professional experience, TGG reports that bottom recoveries typically require several years in the absence of additional activity.

The project area, prior to the implementation of the proposed pipeline project, is an area that is affected by several planned activities that include, at a minimum:

> The maintenance of the mooring basin around, and the navigation channel into the Tilcon Terminal, and
>
> Historical and on-going aquacultural activities on designated grants.

These activities, the effects of storms on the fine to moderate soft bottom environments in the nearshore area; and as reported by USDOC (1972)[12], the "unstable muddy bottom" support limited numbers of benthic species; have long contributed to limiting the project area's ability to succeed beyond a late successional and transitional stage species community.

LaSalle et al (1991) reports that periods for recolonization of bottom disturbances can vary dramatically. These periods can range from a few weeks for pioneer species to several years for late successional species, and are extremely dependent on site specific physical, environmental and anthropogenic conditions. These findings are supported by the database of monitoring data compiled by the Army Corps of Engineers - Disposal Area Monitoring Studies (the DAMOS Program).

LaSalle et al (1991) also summarizes the environmental effects of dredging and disposal operations on several types of marine organisms including finfish. Those effects include:

> **Increased Suspended Solids:** The life stages of all estuarine fish species are fairly tolerant of elevated suspended sediments levels. Fish that utilize naturally turbid waters for spawning and nursery grounds (e.g. estuaries) are typically adapted to elevated suspended solid levels. Channel dredging is typically a short termed event. Various investigators suggest that short termed elevated turbidity levels ranging from 500 - 1000 mg/l are considered safe for estuarine dependent finfish. However, elevated suspended solid levels around dredging operations typically cause short term and localized reductions in dissolved oxygen concentrations. Resuspension of contaminated bottom materials into the water column can strip chemically bound pollutants and redistribute them. Seasonal restrictions may need to address any adverse effects caused by such a redistribution.

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12 USDOC. 1972. Long Island Sound: An Atlas of Natural Resources. NOAA. pp. 52

Sedimentation: Demersal eggs are typically adhesive and typically remain in place along the bottom until larval hatching. Benthic species attach themselves or burrow into the bottom. Sedimentation typically smothers these species and benthic eggs. Also, demersal eggs are subjected to abrasion from coarse sediments. Fine grain materials tend to disperse over a greater bottom area than larger grained sands. Sediment deposition depths of 0.5 mm to 1.0 mm of material are reported to cause 50% mortality to non-encased pelagic fish eggs (White Perch - *Morone americana*) with egg diameters of 0.9 mm. Deposition depths of 2.0 mm cause 100% mortality. Also, deposition depths of 1.0 mm - 2.0 mm limit the settling of shellfish culch. Demersal and pelagic fish are sufficiently mobile to avoid burial during a sedimentation event, and will typically return to areas of disturbance following the cessation of activity. Sessile food resources are also subject to burial during sedimentation. Pre-existing hard bottom substrate and the associated sessile species are also subject to burial. Therefore, changes in the overall habitat conditions will occur.

The FEIS reports that the pipeline will cross the central fine-grained depositional basin of LIS. Also, it reports that a suspended solids plume would extend distances of approximately 360 ft. Based on the reported ebb and flood currents for the project area, the plume will migrate to the east-northeast on the ebb current, and west on the flood current. Since the ebb current is slightly faster than the flood current, TGG would expect the extent of the plume to be slightly greater to the east-northeast than to the west. TGG did not find any discussion on either short- or long termed suspended solids concentrations of this anticipated plume. Near field deposition is estimated to be 1.9 cm, and far field deposition is estimated to be 1.2 mm in thickness.

Bohlen (2001)[13] reports ambient suspended material concentrations within the Connecticut nearshore ranges between 10 -20 mg/l, and display a regular diurnal periodicity in response to tidal forces. In addition, episodic perturbations increase suspended material concentrations to 100 mg/l. These reported perturbations are also subject to episodic diurnal periodicity.

In their "Results and Conclusions" and "Summary" sections, Bohlen et al (2002a)[14] does not speak to suspended solids concentrations within their predicted impact zone. They make a singular statement that states, "The bulk of the remaining mass of resuspended sediments will settle within 300 ft (~100 m)" of its origin "producing a cover of approximately 1.2 mm in thickness in this area. Beyond this secondary impact zone any remaining entrained materials will merge with the background suspended material concentrations...100 mg/l.". They also report, "Despite the finer grained composition of the sediments, this characteristic favors the...rapid settlement of suspended sediments." Additionally, "...for the offshore region beyond MP 12 the impact zone will be confined to the immediate vicinity of the trench and some ancillary scars remaining from anchoring operations."

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13 Bohlen, W.F. 2001. A investigation of sediment transport and circulation in the vicinity of the Thimble Islands, Central Long Island Sound - Project Status Report - November, 2001. UCONN - Dept of Mar Sci, Groton.

14 Bohlen, W.F., M.M.W. Stroebel, M.L. Thatcher. 2002a. An initial evaluation of marine sediment dispersion associated with the installation of the Islander East Natural Gas Pipeline. Prepared for: Natural Resources Group, Inc. Minneapolis, MN.

Roberge (2003) reports that previous work conducted by Bohlen in Milford, CT determined that mechanical clamshell dredging of medium sands with some coarser materials, and some silts generated suspended sediment concentrations of 50 to 250 mg/l. Plume decay occurs rapidly, typically within 60 m downrange of the dredging operation. However, measurable residual concentrations can exist along the bottom up to 920 m downrange. Typical values of depth-averaged suspended sediment concentrations along the centerline of dredge buckets during water entry and withdrawal operations range between 50 - 500 mg/l, during rapid retrieval (Source Strength 1,684 g/s). Roberge (2003) also reports potential suspended concentrations ranges from the dredge trench centerline for this project as summarized in Table 2.

Modeled suspended solid concentrations generated by dredging ranged from a maximum of 671 mg/l at 5 m (16.5 ft) from the trench centerline; to a minimum of 1 mg/l 1000 m (3300 ft) from the trench centerline. At a Source Strength of 1,684 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline were at magnitude concentrations of 10^2 mg/l; at 100 m (330 ft), were at magnitude concentrations of 10^1 mg/l; and at ≥ 400 m (1300 ft) were at magnitude concentrations of < 10 mg/l. At a Source Strength of 454 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline ranged between 50 - 200 mg/l, and at distances ≥100 m (330 ft) were at magnitude concentrations of < 10 mg/l. At a Source Strength of 243 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline were < 100 mg/l, and at distances ≥100 m (330 ft) were at magnitude concentrations of < 10 mg/l.

Please refer to Figures 2 - 4 in Appendix A of Roberge (2003) for a graphic depiction of plume extent. At the source strength rate of 1684 g/s, suspended solids concentrations at the Thimble Islands equal ≤ 3 mg/l. The sub- and intertidal rocky outcrops immediately to the west of the Thimbles are also subjected to nearly absent turbidity, with plume concentrations of 3 - 10 mg/l.

Roberge (2003) also reports potential sediment deposition resulting from the anticipated turbidity plume, from the dredge trench centerline as summarized in Table 3. Modeled sedimentation from the anticipated turbidity plume ranged from a maximum of 2.7 mm at a distance of 5 m from the trench centerline; to a minimum of 0.0 mm at a distance of 200 m from the trench centerline. At a Source Strength of 1,684 g/s, all modeled sedimentation 5 m from the centerline ranged 1.4 mm to 2.7 mm, and at ≤ 100 m (330 ft) sediment thicknesses were estimated to be 0.1 mm. No measurable deposition is predicted beyond 100 m (330 ft). At a Source Strength of 454 g/s, the only modeled measurable deposition ranged from 0.4 mm to 0.7 mm; and at Source Strength of 243 g/s, the only modeled measurable deposition ranged from 0.2 mm to 0.4 mm. ASA (2002)[15] reports deposition patterns > 0.05 ft (1.5 cm) caused by the erosion of the spoil mounds during a modeled 90-day (long-term) period to occur 170± ft west of the trench and 460± ft to the east of the trench; and as expected is offset to the east, based on mean LIS current direction. In the short-term (20-day model period), deposition patterns > 0.05 ft (1.5 cm) extend 50 ft to the east and west of the trench.

Therefore based on LaSalle et al (1991) and these data developed by Roberge and ASA, it appears that sedimentation in the amounts to cause 50 - 100% mortality to demersal and benthic eggs and species could occur within, and to ≤ 100 ft of the trench footprints.

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15 Swanson, C., C. Galagan and C. Dalton. 2002. Dredged material mound dispersion analysis using LTFATE. Applied Science Associates, Inc., Narragansett, RI. Prepared for Natural Resources Group, Inc., Minneapolis, MN.

Table 2: Summary Data Potential Suspended Sediment Concentrations (mg/l)

Station	Tidal Current	Normal Distance From Trench Centerline in Meters			
		5	100	400	1000
Source Strength (R) = 1,684 g/s					
MP 10.9	Flood	671	34	8	3
	Ebb	354	18	4	2
MP 11.5	Flood	527	26	7	3
	Ebb	299	15	4	1
MP 12	Flood	420	21	5	2
	Ebb	253	13	3	1
Source Strength (R) = 454 g/s					
MP 10.9	Flood	177	9	2	1
	Ebb	94	5	1	0
MP 11.5	Flood	139	7	2	1
	Ebb	79	4	1	0
MP 12	Flood	111	6	1	1
	Ebb	67	3	1	0
Source Strength (R) = 243 g/s					
MP 10.9	Flood	97	5	1	0
	Ebb	51	3	1	1
MP 11.5	Flood	76	4	1	0
	Ebb	43	2	1	0
MP 12	Flood	61	3	1	0
	Ebb	37	2	0	0

Table 3: Summary Data - Potential Deposited Sedimentation Thicknesses (mm)

Station	Tidal Current	Normal Distance From Trench Centerline in Meters			
		5	100	400	1000
Source Strength (R) = 1,684 g/s					
MP 10.9	Flood	2.7	0.1	0	0
	Ebb	1.4	0.1	0	0
MP 11.5	Flood	2.5	0.1	0	0
	Ebb	1.4	0.1	0	0
MP 12	Flood	2.4	0.1	0	0
	Ebb	1.4	0.1	0	0
Source Strength (R) = 454 g/s					
MP 10.9	Flood	0.7	0	0	0
	Ebb	0.4	0	0	0
MP 11.5	Flood	0.7	0	0	0
	Ebb	0.4	0	0	0
MP 12	Flood	0.6	0	0	0
	Ebb	0.4	0	0	0
Source Strength (R) = 243 g/s					
MP 10.9	Flood	0.4	0	0	0
	Ebb	0.2	0	0	0
MP 11.5	Flood	0.4	0	0	0
	Ebb	0.6	0	0	0
MP 12	Flood	0.3	0	0	0
	Ebb	0.2	0	0	0

Should side cast storage of material re-emerge as a preferred project alternative, Roberge (2003) reports that the proposed piles will have heights of 10 - 11 ft. These pile heights will extend to between 2 - 10 ft of the water surface at various tidal stages, and in several locations. These piles will present temporary navigational hazards and be exposed to both ambient and storm generated wave action, breaking wave conditions, and deepwater/wave generated water velocities. During the period between dredging/trenching and backfilling, the side cast piles may be exposed to short-termed storm effects and will be eroded and be redistributed. The transport of these materials will likely extend to the reaches of the defined sediment plume (Roberge 2003). While the periods appear short between opening the trench and backfilling, nearshore storm and tidal effects can be unpredictable. In the best scenario and if the piles remain in place, the backfilling of the basin and trench will cause a second plume episode of elevated suspended solids and sedimentation. In either case, the impact of erosion or of the backfilling could be as much as that of the original dredging and would cumulative.

A concern was raised regarding the potential "toxicity" of the drill lubricating bentonite slurry. Bentonite is a naturally formed fine-particulate clay material that when moistened, forms a dense cake-like solid, but when saturated forms a smooth creamy-like fluid. As with any material used or consumed in extreme amounts, adverse effects could be realized; however, based on an extensive literature search, its recommended use in various applications by the environmental agencies, and discussions with other professionals; bentonite is not considered as a toxin. It behaves in a water column as any dense, inert and fine particle material will behave. It will flock, forming a dense turbid cloud. When the drill pierces the sidewall of the transition trench, there will be a small release of the slurry into the water column. The turbidity cloud produced will be small and isolated, and should mimic previously described plume characteristics, or rapidly dissipate into any background concentrations.

SECTION THREE: BIOLOGICAL COMMUNITY AND ANTICIPATED IMPACTS

Summary of the Invertebrate Assessment for the Project Area

The FEIS reports, based on several investigations conducted by Pellegrino (2002a and b)[16], the nearshore subtidal area in the path of the proposed pipeline is predominately soft bottom habitat with interspersed rocky outcrops. The soft bottom habitat serves as valuable commercial and recreational shellfish habitat. The proposed alignment passes through town managed shellfish grants and recreational fishing areas, and through two unlisted state managed shellfish leased area. The soft substrate in the project area includes: anoxic mud, soft mud and coarse and silty sand. Evidence of Quahaugs (*Mercenaria mercenaria*), Eastern Oysters (*Crassostrea virginica*) and Surf Clams (*Mulinia* sp.) exist throughout the nearshore project area, indicative of shellfish habitat. Various other benthic species were also evident throughout this habitat (e.g. crabs, whelks, worms and other clams).

Rocky subtidal outcrops, functioning as reef-like (fouling) habitat, are interspersed among the dominant soft substrates. Fouling species include the macroalgae (Rockweeds - *Fucus* sp. and *Ascophyllum* sp., and Sea

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16 Pellegrino, P.E. 2002a. Bottom characterization surveys of selected subtidal and nearshore environments off Juniper Point (Branford, CT) - Final Report. Prepared for Islander East Pipeline Company, Prepared by Coastal Resource Analysts. 21 p.

and

__________. 2002b. Macrobenthic community structure along the proposed Islander East Gas Pipeline route in Long Island Sound - Final Report. Prepared for Islander East Pipeline Company, Prepared by Coastal Resource Analysts. 14 p. w/Figures.

Lettuce - *Ulva* sp.), Blue Mussels (*Mytilus edulis*), Oyster Drills (*Urosalpinx cinera*), Dove Snails (*Mitrella lunata*), Red-beard Sponge (*Microcionia prolifera*), Convex Slipper Shell (*Crepidula plana*) and Slipper Shell (*C. fornacata*).

TGG agrees with Pellegrino (2002a & b) that the dominant invertebrate community is comprised of late successional and transitional stage species.

Summary Fishery Assessment for the Project Area

The FEIS reports the following representative marine finfish species, as important species known to occur in the project area.

Diadromous Species	**Marine Species**		
		Atlantic Mackerel	Sand Eel
		Pollack	Sand Lance
	Butterfish	Red Hake	American Lobster
Brook Trout*	Summer Founder	Windowpane	Crab
Brown Trout*	Silver Hake	Striped Bass	Oyster Clam
Atlantic Salmon*	Weakfish	Sturgeon	Conch
Eels	Winter Flounder	Tautog	Scallop
Menhadens	Scup	Cunner	Squid
Smelt	Black Sea Bass	Sandbar Shark	
Shad	Bluefish	Sand Tiger Shark	

* sea run species

Table 4, as reproduced from the FEIS, reports the Essential Fish Habitat (EFH) - Designated Species for the project area. EFH is defined as "those waters, aquatic areas, and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity...and to fulfill their associated physical, chemical and biological requirements. EFH provides a suite of indicator species that assist in evaluating status and/or changes in environmental conditions, and any alterations to those conditions.

While designated EFH species may address regulatory requirements, given the extent and complexity of the proposed pipeline project and the sensitive commercial and recreational nearshore resources within the Connecticut Mainland approach, TGG would recommend the applicant should expand the indicator species database to include other species that are documented to utilize the project area (e.g. Stone et al 1994[17]). As reported, the designated Estuarine Living Marine Resources (ELMR) program species were selected based on four (4) selection criteria that include: Commercial Value, Recreational Value, Ecological Value and indicators of environmental stress.

Appendix A presents a comprehensive list of ELMR fisheries resources expected to be found in the LIS estuary. This list includes 50 species. Variables such as water quality, salinity regime, substrate types will govern potential resource and habitat usage in the project area. TGG has short-listed those species which would be more than likely present in the project area. Criteria for short-listing included distribution within the mixing tidal regime, vertical distribution within the lower portion of the water column (benthic and

17 Stone, S.L, T.A. Lowery, J.D. Field, C.D. Williams, D.M. Nelson, S.H. Jury, M.E. Monaco and L. Andrease. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep No 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 280 p.

demersal types), and benthic residential and breeding habits. Species may fit all or a portion of these criteria. Many of which are transient or migratory.

Table 4: Summary of Essential Fish Habitat Designations (reproduced from FEIS Table 3.4.1-4)

Fish and Shark Species	Eggs	Larvae	Juveniles	Adults
Atlantic Mackerel - *Scomber scombrus*	x	x	x	x
Atlantic Salmon - *Salmo salar*			x	x
Atlantic Sea Herring - *Clupea harengus*			x	x
American Plaice - *Hippoglossoides*			x	x
			x	x
platessoides			x	x
Black Sea Bass - *Centropristus straita*	x	x	x	x
Bluefish - *Pomatomus saltatrix*	x	x	x	x
Cobia - *Rachycentron canadum*			x	x
King Mackerel - *Scomberomorus cavalla*	x	x	x	x
Pollack - *Pollachius virens*	x	x	x	x
Red Hake - *Urophycis chuss*	x	x	x	x
			x	
Scup - *Stenotomus chrysops*				x
Spanish Mackerel - *S. maculatus*	x	x	x	
Summer Flounder - *Paralicthys dentatus*	x	x	x	x
Whiting - *Merluccius bilinearis*	x		x	x
Windowpane - *Scopthalmus aquosus*				x
Winter Flounder - *Pseudopleuronectes*		x		x
americanus		x		
Longfin Inshore Squid - *Loligo pealeii*				
Blue Shark - *Prionace glauca*				
Sandbar Shark - *Charcharinus plumbeus*				
Sand Tiger Shark - *Odontaspis taurus*				

Table 5 presents this short-list of ELMR species significant to the project area. Twenty three (23) species are demersal or benthic species which are typically distributed at or near the bottom. Also, the egg distribution of ten (10) of the short-listed species are laid on, or settle to the bottom. The four species of *Arthropoda* are benthic or demersal species, and are ovoviviporous (in these cases holding their eggs on specialized body appendages). The shellfish identified are benthic species (attached and burrowing). Several species are either anadromous or catadromous.

Summary of Winter Flounder and American Lobster Habitat Requirements

Winter flounder habitat extends to the tide mark at specific tidal stages, including extreme high tides. They can also run up into the extreme brackish reaches of coastal rivers. Lower limits have not been specifically determined, but flounder are common down to 100± ft. Offshore (Georges Bank), flounder have been taken as deep 270± ft. Smaller fish typically inhabit shoal water, while larger specimens tend to go deeper. However, large adults have been taken in shallows. Young fry are chiefly found in the shallows.

TABLE 5: SHORT-LISTED ELMR SPECIES AT THE PROPOSED PROJECT AREA

COMMON NAME	FISHERY TYPE	VERTICAL DISTRIBUTION	EGG DISTRIBUTION
Blue Mussel	Invertebrate-Shellfish	benthic attached	buoyant pelagic
American Oyster	Invertebrate-Shellfish	benthic attached	buoyant pelagic
Northern Quahaug	Invertebrate-Shellfish	benthic burrower	buoyant pelagic
Softshell Clam	Invertebrate-Shellfish	benthic burrower	buoyant pelagic
Daggerblade Grass Shrimp	Invertebrate-Arthropod-Bait	demersal	ovoviviporous-attached
Sevenspine Bay Shrimp	Invertebrate-Arthropod-Bait	demersal	ovoviviporous-attached
American Lobster	Invertebrate-Arthropod	benthic	ovoviviporous-attached
Blue Crab	Invertebrate-Arthropod	benthic	ovoviviporous-attached
Skates	Cartilaginous Fish	benthic	oviparous/egg sack attached
American Eel	Bony Fish	pelagic	catadromous
Blueback Herring	Bony Fish	pelagic	anadromous
Alewife	Bony Fish	pelagic	anadromous
American Shad	Bony Fish	pelagic	anadromous
American Menhaden	Bony Fish	pelagic	spawns at sea
Atlantic Herring	Bony Fish	pelagic	sinking, non-bouyant
Bay Anchovy	Bony Fish-Baitfish	demersal	demersal
Rainbow Smelt	Bony Fish-Baitfish	demersal	sandy beaches
Atlantic Tomcod	Bony Fish	demersal	demersal
Red Hake	Bony Fish	demersal	demersal
Oyster Toadfish	Bony Fish	demersal	demersal
Sheepshead Minnow	Bony Fish-Baitfish	pelagic	sinking, non-buoyant
Killifish	Bony Fish-Baitfish	pelagic	sinking, non-buoyant
Silversides	Bony Fish-Baitfish	pelagic	benthic, sandy bottom
Northern Pipefish	Bony Fish-Baitfish	demersal/grasses	benthic grasses
Northern Searobin	Bony Fish	demersal	pelagic buoyant
White Perch	Bony Fish	pelagic	anadromous/non-buoyant
Striped Bass	Bony Fish	pelagic	anadromous/non-buoyant
Bluefish	Bony Fish	pelagic	buoyant
Scup	Bony Fish	pelagic	buoyant
Weakfish	Bony Fish	pelagic	buoyant
Tautog	Bony Fish	demersal	buoyant

TABLE 5 cont'd: SHORT-LISTED ELMR SPECIES AT THE PROPOSED PROJECT AREA

Cunner	Bony Fish	demersal	buoyant
American Sand Lance	Bony Fish-Baitfish	benthic	benthic/sandy bottom
Gobies	Bony Fish-Baitfish	pelagic	unknown
Atlantic Mackerel	Bony Fish	pelagic	buoyant
Butterfish	Bony Fish	demersal	buoyant
Windowpane Flounder	Bony Flatfish	benthic	buoyant
Winter Flounder	Bony Flatfish	benthic	buoyant
Hogchoker	Bony Flatfish	benthic	unknown

Flounder can be commonly found on bottom types varying from soft muddy sand, with and without eelgrass *(Zostera marina)*; clean sand; clay; and pebbly/gravelly bottoms.

As adults, winter flounder migrate into shoal waters in the late autumn when water temperatures fall, and back to deeper waters in the spring when water temperatures rise. Apart from seasonal movements, winter flounder are typically stationary in nature (CTDEP 1977)[18]. The winter flounder is a winter/spring breeder, typically spawning from December - April in LIS.

Lobsters reside along hard bottoms or bottoms with relief and or shelter conditions. Lobsters are scavengers and feeding activities slow in colder waters and increase as water temperatures increase. After breeding, eggs are carried by the female for 11-12 months . At maturity, eggs are hatched when the female agitates them by shaking her body and the offspring are cast off. The young drift as pelagic zooplankton then settle as early benthic forms with a soft carapace and require stable hard substrates with relief and crevices, or with ample sheltering features until maturity.

SECTION FOUR: CONCLUSIONS

The proposed actions will cause an estimated direct displacement or damage to 440± ac of nearshore bottom area between MP 10.1 - 12.5. These impacts will be caused by the dredging/trenching, barge anchor scars and anchor cable sweeps. The anticipated bottom damage will alter an existing productive shellfish habitat, and an existing invertebrate community structure inclusive of a late successional/transition structure to a pioneer/opportunistic structure. After all project related activities and secondary conditions associated with the construction have ceased, the bottom will recover after several years and return to the existing condition.

18 CTDEP. 1977. *Long Island Sound: An Atlas of Natural Resources*. CTDEP - Coastal Area Management Program, NOAA/CZM. pp. 52.

This project modification that eliminates the side cast piles reduces the direct surface area impacts. The reduction of cover material from 3.0± ft to 1.5± ft will create a bowl depression of 1.5± ft over 0.75 ac of the bottom, and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. These changes in relief are gradual and shallow, and will impact the post construction nearshore bottom. The use of engineered fill will create a varied benthic habitat, shelter/relief, and should enhance nearshore bottom conditions.

In addition to direct bottom damage, indirect impacts caused by elevated suspended solid concentrations at or near the bottom may include, a temporal turbidity plume downdrift (tidal/current direction) of the specific construction locus, sedimentation over downdrift bottom (soft and hard substrates), and an anoxic episode(s).

LaSalle et al (1991) indicates that turbidity ranges of up to 500-1000 mg/l are considered safe for estuarine dependent species. Bohlen (2001) estimates that ambient turbidity concentrations range from 10-20 mg/l in the Connecticut nearshore area. Episodic perturbations under ambient conditions may cause a rise in suspended concentrations to ±100 mg/l. Bohlen (2002a) reports that any plume generated (no specific concentration reported) will either merge with background concentrations, or will decay within 300 ft (91 m) of the dredged trench. Roberge (2003) reports that mechanical clamshell dredging of medium sands with some coarse and silty fractions will generated suspended solids concentrations ranging from 50-700 mg/l, and the plume will decay rapidly. These concentrations are reported within 16.5 ft (5 m) of the centerline of the dredged trench. Measurable residual concentrations can exist along the bottom up to 3040± ft (920 m). Concentrations of suspended solids are directly related to the speed of the bucket retrieval during the dredging.

LaSalle et al (1991) reports that sedimentation deposits of 0.5 - 1.0 mm will cause up to 50%, and deposition of up to 2.0 mm will cause 100% mortality to non-encased pelagic fish eggs with diameters of up to 0.9 mm. Deposition between 1.0 - 2.0 mm will limit the settling of shellfish culch. Roberge (2003) reports potentially damaging sedimentation thicknesses within 16.5 ft (5 m) of the trench centerline during various retrieval rates. Near- and far field deposition of suspended solids may cause a measurable cover, or a thin veneer of fine particle cover over proximal hard bottom substrate; and again may adversely effect the fouling capacities of, or sheltering resources on, or within these substrates. Sedimentation will cover existing unaffected soft bottom conditions, possibly smothering existing resources; or cover limited hard substrate conditions, reducing both fouling and sheltering hard substrate conditions, and possibly smothering existing resources. Benthic species are so sensitive (e.g. Eastern Oyster), that thin sedimentation veneers can alter a hard substrates ability to foul. With the presence of anoxic muds and silts temporary anoxic episodes should be anticipated.

The project should consider expanding the scope of species of concern to include not only the EFH designated species, but also those other species identified which utilize the LIS nearshore areas (e.g. those additional ELMR species not included in the EFH list etc.). During the construction period motile pelagic, demersal and benthic species will evacuate the 440± ac direct impact area. Sessile species will be lost when bottom disruptions are experienced. Upon completion, many of the motile species will return. However, the bottom will be barren with little to no relief in the short term, and lacking a benthic invertebrate community. Beyond the immediacy of the construction period, the soft bottom will recruit a limited pioneer/opportunistic structure. Based on both historical and existing project area activities, it could take several years for the soft bottom to return to the existing successional/transition structure.

The EFH species list designated for the project site appears skewed toward pelagic species. Whereas, the ELMR species list includes several demersal and benthic species and appears more representative of those species utilizing the project area. Several of the ELMR species, and some of the EFH species identified are demersal or benthic species which are typically distributed at or near the bottom. Also, the egg distribution of ten (10) of these species are laid on, or settle to the bottom. The identified *Arthropoda* are benthic or demersal species. The shellfish identified are benthic species (attached and burrowing).

The anticipated direct impacts, bottom turbidity and sedimentation will affect portions of the existing benthic environment; therefore, disrupting the habitat conditions for various shellfish and finfish. These disruptions will be temporal, assuming natural recovery, the nearshore area will exhibit noticeable changes.

Recommendations

Impacts of primary concern should include the 440± ac of direct displacement or damage. These losses will have a dramatic effect in the short term fishery (commercial and recreational). In addition, secondary concern should include the various turbidity events anticipated, and the deposition of sediments on the hard substrate habitats.

TGG recommends that specific construction supervision and mitigation, and compensatory resource mitigation should be considered to protect adjacent resources and compensate (in- and out of kind) for lost valuable resources. Project mitigation should include, but not be limited to:

Construction Mitigation

1) Require "third party oversight for all construction operations and monitoring, and authorizing said party to shut down operations should operational or permitting thresholds limits be exceeded.

2) The dredging contractor should be required to prepare and implement a project specific "Dredge Management Plan" to establish performance standards to define monitoring protocols, specific protective mitigation actions, and the means to which the contractor will employ to minimize construction impacts (e.g. silt curtains/barriers, acoustic deterrents, bucket retrieval rates etc.).

3) Define the operational limits for sediment plume release and suspended solids concentrations that will cause the termination of dredging/seaplowing, should those limits be exceeded.

4) Limit construction to construction windows that will minimize impacts to areal flora and fauna, including periods of productivity and spawning.

5) No side cast disposal of dredged material should be allowed.

6) Use of sealed environmental buckets to limit turbidity generated by resuspension of materials in the water column during hauling and retrieval.

Compensatory Resource/Habitat Mitigation -

1) Recommend the use of engineered fill.

2) The proponent and the Client should agree upon a shellfish protection and restoration plan to protect this vital commercial and environmental resource. This plan should include at a minimum:

    define all productive resources within the pipeline path,
    develop a relay plan to harvest existing individuals, and utilize or replant all, or a portion them in another suitable areal bed,
    once the construction activities are completed and the nearshore bottom has stabilized, a multi-year shellfish seeding plan should be developed and approved by the resource agency(s), and implemented by the proponent, and
    develop and implement a monitoring program to assure that replanted shellfish beds are reasonably successful.

3) Since the bottom will be barren with little to no relief immediately following construction and existing hard substrate bottom, may be altered by sedimentation; the applicant should commit to placing protective structure and relief to provide sheltering habitat for vulnerable benthic species (e.g. BBP lobsters); and

4) develop and implement 5 year monitoring program to define all sensitive resources in the nearshore area and document the recovery of benthic habitats in the project area.

APPENDIX A

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Blue Mussel (1)	*Mytilis edulis*	E: common (M)	E: common April-July and October, rare August-September
		L: common (M)	L: common April-July and October, rare August-September
		J: common (M)	J: common all year
		S: common (M)	S: common April-July and October, rare August-September
		A: common (M)	A: common all year
Bay Scallop (1)	*Argopecten irradians*	E: rare (M)	E: rare June-August
		L: rare (M)	L: rare June-September
		J: rare (M)	J: rare all year
		S: rare (M)	S: rare June-August
		A: rare (M)	A; rare all year
American Oyster (1)	*Crassostrea virginica*	E: abundant (M)	E: abundant August, common October
		L: abundant (M)	L: abundant August, common March-October-November
		J: abundant (M)	J: abundant all year
		S: abundant (M)	S: abundant August, common October
		A: abundant (M)	A: abundant all year
Northern Quahaug (1)	*Mercenaria mercenaria*	E: abundant (M)	E: common May and September, abundant June-August
		L: abundant (M)	L: common May and October, abundant June-September
		J: abundant (M)	J: abundant all year
		S: abundant (M)	S: common May and September, abundant June-August
		A: abundant (M)	A: abundant all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Softshell Clam (1)	*Mya arenaria*	E: common (M)	E: rare April, common May to September
		L: common (M)	L: rare April, common May to September
		J: common (M)	J: common all year
		SA: common (M)	SA: rare April, common May to September
		A: common (M)	A: common all year
Daggerblade Grass (1) Shrimp	*Palaemonetes pugio*	E: common (M)	E: rare May and October, common June through September
		L: common (M)	L: rare May and October, common June through September
		J: abundant (M)	J: rare May and December, common June and November, and abundant July through October
		SA: common (M)	SA: rare May and October, common June through September
		A: abundant (M)	A: common December through May, abundant July through November
Sevenspine Bay Shrimp (3)	*Crangon septemspinosa*	E: abundant	E: rare January and February and December, common March through May October and November, and abundant June through September
		L: abundant	L: rare January and February and December, common March through May October and November, and abundant June through September
		J: highly abundant (M)	J: abundant January through March and December, highly abundant April through November
		SA: abundant	SA: rare January and February and December, common March through May October and November, and abundant June through September
		A: highly abundant (M)	A: abundant January through March and December, highly abundant April through November

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
American Lobster [1]	*Homerus americanus*	E: abundant (M)	E: highly abundant all year
		L: abundant (M)	L: abundant May and September, highly abundant June through August
		J: abundant (M)	J: highly abundant all year
		Mt: abundant (M)	Mt: highly abundant June through November
		A: abundant (M)	A: highly abundant all year
Blue Crab [3]	*Callinectes sapidus*	E: common (M) and (S)	E: common May through September
		L: rare (M)	L: rare May through September
		J: common (M) and (T)	J: common all year
		Mt: common May through October	Mt: common May through October
		A: common (M) and (T)	A: common all year
Cownose Ray [1]	*Rhinoptera bonansus*	P: rare (M)	P: rare June through October
		J: rare (M)	J: rare June through October
		Mt: rare (M)	Mt: rare June through October
		A: rare (M)	A: rare June through October
Shortnose Sturgeon [1]	*Acipenser brevirostrum*	E: common (M)	E: rare April through June
		L: rare (T)	L: rare May through August
		J: rare (M), common (T)	J: common all year
		SA: rare (T)	SA: rare April through June
		A: rare (M) and (T)	A: rare all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
American Eel (2)	*Anguilla rostrata*	L: common (M) and rare (T)	L: common March through August
		J: common (M) and (T)	J: common all year
		A: common (M) and abundant (T)	A: abundant September through November
Blueback Herring (2)	*Alosa aestivalis*	E: common (M) and abundant (T)	E: common May and July through September
		L: common (M) and abundant (T)	L: common May and July through September
		J: common (M) and highly abundant (T)	J: common January through June and November through December, abundant October, and highly abundant July through September
		SA: common (M) and abundant (T)	SA: common May and July through September
		A: highly abundant (M) and (T)	A: common January through March and August through December, abundant April and June through August, and highly abundant May
Alewife (2)	*A. pseudoharangus*	E: abundant (T)	E: common March and July, abundant April through June
		L: common (M), highly abundant (T)	L: common April and July, highly abundant May and June
		J: highly abundant (M) and (T)	J: common January through May and November and December, highly abundant May through October
		SA: highly abundant (T)	SA: common April and July, highly abundant May and June
		A: abundant (M) and (T)	A: common January through April and July through December, highly abundant May and June
American Shad (2)	*A. sappidissima*	E: common (M) and (T)	E: abundant April through July
		L: abundant (M) and (T)	L: common May and July through August, abundant June
		J: abundant (M) and (T)	J: common January through may and October though December, abundant June through November
		SA: abundant (T)	SA: abundant May through July
		A: abundant (M) and (T)	A: abundant April through July

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
American Menhaden (1)	*Brevoortia tyrannus*	L: abundant (M) and common (T)	E: common April and August through September, abundant May through July, rare October and November
			L: common April and August through November, abundant May through July, rare December
		J: highly abundant (M), abundant (T)	J: common April through May and October through November, abundant June through July, highly abundant August
		SA: highly abundant (T)	SA: common August and October, abundant May and September, highly abundant June through August, rare November
		A: highly abundant (M) and common (T)	A: common April and August through November, highly abundant May through July, abundant August
Atlantic Herring (1)	*Clupea harengus*	L: rare (M)	L: rare March through May
		J: common (M)	J: common all year
		A: common (M)	A: abundant January through May and November through December, common May through October
Channel Catfish (1)	*Ictalurus punctatus*	E: rare (M) and (T)	E: rare June through July
		L: rare (M) and (T)	L: rare June through July
		J: rare (M), common (T)	J: common all year
		SA: rare (M) and (T)	SA: rare June through July
		A: rare (M), common (T)	A: common all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Bay Anchovy [1]	*Anchoa mitchii*	E: highly abundant (M), common (T)	E: abundant April and August
		L: highly abundant (M), abundant (T)	L: rare May and November, abundant June and August through September, highly abundant July, common October
		J: abundant (M), common (T)	J: abundant all year
		SA: highly abundant (M), common (T)	SA: abundant April and August
		A: abundant (M), common (T)	A: common January through June and October through December, abundant July through September
Rainbow Smelt [1]	*Osmerus mordax*	E: common (M), abundant (T)	E: rare January and February, common March and May, abundant April
		L: abundant (M) and (T)	L: rare February and march, common April, abundant May and June
		J: rare (M), common (T)	J: common March through August, rare September through December
		SA: common (M), abundant (T)	SA: rare January and February, common March and May, abundant April
		A: rare (M), common (T)	A: common January through May and October through December, rare July through September
Atlantic Salmon [1]	*Salmo salar*	J: rare (M) and (T)	J: rare March through August
		A: rare (M) and (T)	A: rare February through November

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Atlantic Tomcod [1]	*Microgadus tomcod*	E: abundant (M), common (T)	E: abundant January and February, common March and November through December
		L: abundant (M), common (T)	L: common January through February and December, abundant March through May
		J: abundant (M), common (T)	J: abundant all year
		SA: abundant (M), common (T)	SA: abundant December and January, common February and November
		A: common (M), common (T)	A: common all year
Pollock [1]	*Pollachius virens*	L: rare (M)	L: rare March and April
			J: common December though March
		J: rare (M)	A: common December though March
Red Hake [1]	*Urophycis chuss*	J: common (M)	J: rare December through February, common March through April and July through October, abundant May through June and November
		A: common (M)	A: rare December through February, common March through April and July through October, abundant May through June and November
Oyster Toadfish [1]	*Opsanus tau*	E: common (M)	E: common June through September
		L: common (M)	L: common June through September
		J: common (M)	J: common all year
		SA: common (M)	SA: common June through September
		A: common (M)	A: common all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Sheepshead Minnow [1]	*Cyprinodon variegatus*	E: common (M)	E: common June through September
		L: common (M)	L: common June through October
		J: rare (M) and (T)	J: common all year
		SA: common (M)	SA: common June through September
		A: rare (M) and (T)	A: common all year
Killifish [1]	*Fundulus sp.*	E: abundant (M), common (T)	E: common May and August, abundant June and July
		L: abundant (M), common (T)	L: common May and September, abundant June and August
		J: abundant (M), common (T)	J: abundant all year
		SA: abundant (M), common (T)	SA: common May and August, abundant June and July
		A: abundant (M), common (T)	A: abundant all year
Silversides [1]	*Menidia menidia*	E: abundant (M), common (T)	E: common May and August, abundant June and July
		L: abundant (M), common (T)	L: common May and August, abundant June and July
		J: highly abundant (M), common (T)	J: abundant September through May, highly abundant June through August
		SA: abundant (M), common (T)	SA: common May and August, abundant June and July
		A: abundant (M), common (T)	A: abundant September through May, highly abundant June through August
Northern Pipefish [1]	*Syngnnathus fuscus*	L: common (M)	L: rare May through October
		J: common (M)	J: rare October through April, common May through September
		SA: common (M)	SA: rare April, common May through August
		A: common (M)	A: common all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Northern Searobin [1]	*Prionotus carolinus*	E: common (M)	E: rare May and September, common June through August
		L: common (M)	L: rare May and September, common June through August
		J: common (M)	J: common April through November
		SA: common (M)	SA: rare May and September, common June through August
		A: common (M)	A: common April through November
White Perch [1]	*Morone americana*	E: common (M), highly abundant (T)	E: common April and August, highly abundant May through July
		L: common (M), highly abundant (T)	L: common April and September, highly abundant May through August
		J: common (M), highly abundant (T)	J: abundant October through June, highly abundant July through September
		SA: common (M), highly abundant (T)	SA: common April and August, highly abundant May through July
		A: common (M), highly abundant (T)	A: abundant October through April, highly abundant May through September
Striped Bass [1]	*M. saxatillis*	J: abundant (M), common (T)	J: common January through March, abundant April through December
		A: common (M) and (T)	A: common December through May and September through October, abundant June through July and October through November
Black Sea Bass [1]	*Centropristis striata*	J: rare (M)	J: rare December through March, common April through November
		A: rare (M)	A: rare all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Yellow Perch [1]	*Perca flavescens*	E: rare (M), abundant (T)	E: abundant April, common May
		L: common (M), abundant (T)	L: common April and June through July
		J: rare (M), common (T)	J: common all year
		SA: rare (M), abundant (T)	SA: abundant April, common May
		A: rare (M), common (T)	A: common all year
Bluefish [1]	*Pomatomus saltatrix*	J: abundant (M), rare (T)	J: common June, abundant July through October, rare November and december
		A: common (M)	A: common April through May and September through November, abundant June through August, rare December
Scup [1]	*Stenotomus chrysops*	E: rare (M)	E: common May and August, abundant June through July, rare September
		L: rare (M)	L: common May and August, abundant June through September
		J: rare (M)	J: abundant May and October, highly abundant June through September, common November
		A: rare (M)	SA: common May and August, abundant June through July, rare September
			A: common May and November, abundant June through September, highly abundant October
Weakfish [1]	*Cynoscion regalis*	J: abundant (M)	E: rare May through September
		A: common (M)	L: rare June through September
			J: common June through September and November, abundant October
			SA: rare May through September
			A: common May through November

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Spot (1)	*Leiostomus xanthurus*	J: rare (M)	J: rare April through November
		A: rare (M)	A: rare April through November
Northern Kingfish (1)	*Menticirrhus saxatillis*	J: rare (M)	E: rare June through September
			L: rare June through September
			J: rare April through November
			SA: rare June through September
		A: rare (M)	A: rare April through November
Mullet (1)	*Mugil sp.*	J: rare (M) and (T)	J: rare April through November
		A: rare (M) and (T)	A: rare April through November
Tautog (1)	*Tautoga onitis*	E: abundant (M)	E: rare April and October, common May and August through September, abundant June through July
		L: common (M)	L: rare May, common June through August
		J: common (M)	J: common all year
		A: common (M)	SA: rare April and October, common May and August through September, abundant June through July
			A: rare December through March, common April through November
Cunner (1)	*Tautogolabrus adsperus*	E: common (M)	E: common May and June, abundant July through August, rare September and October
		L: common (M)	L: common May, abundant June through August, rare September and October
		J: common (M)	J: common all year
		A: common (M)	SA: common May, highly abundant June through July, abundant August, rare September and October
			A: common all year

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
American Sand Lance (1)	*Ammodytes americanus*	E: rare (M)	E: highly abundant December and January, abundant February through March and November
		L: common (M)	L: highly abundant December through February, abundant March, common April. Rare May and June
		J: common (M)	J: abundant November through May, common June through October
		SA: rare (M)	SA: highly abundant December and January, abundant February and November, common March
		A: common (M)	A: abundant November through May, common June through October
Gobies (1)	*Gobiosoma sp.*	E: common (M)	E: rare May and August, common June and July
		L: common (M) and (T)	L: rare June and September, common July and August
		J: common (M), rare (T)	J: common all year
		SA: common (M)	SA: rare June and October, common July through September
		A: common (M), rare (T)	A: common all year
Atlantic Mackerel (1)	*Scomber scombrus*	J: rare (M)	E: common April and June, abundant May
			L: common May, rare June
			J: common April through November
			SA: rare April through June
			A: common April through November

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Butterfish [(1)]	*Peprilus triacanthus*	J: abundant (M), rare (T)	E: common June through August, rare September
		A: abundant (M)	L: common June through August, rare September through November
			J: common May through June and November, abundant July and November, highly abundant August through October
			SA: common June through August, rare September
			A: common May through June and November, abundant July and November, highly abundant August through October
Summer Flounder [(1)]	*Paralichthys dentatus*	J: rare (M)	J: rare March through November
		A: rare (M)	A: rare March through November
Windowpane Flounder [(1)]	*Scopthalamus aquosus*	E: highly abundant (M)	E: abundant April and June, highly abundant May, common July and August, rare September through November
		L: abundant (M)	L: common May and August through October, rare November
		J: highly abundant (M), rare (T)	J: abundant December through March and July through October, highly abundant April through June and November
		SA: highly abundant (M)	SA: abundant April and June, highly abundant May, common July and August, rare September through November
		A: highly abundant (M), rare (T)	A: abundant December through March and July through October, highly abundant April through June and November

TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

Common Name	Scientific Name	Spatial Distribution and Abundance	Temporal Distribution
Winter Flounder [1]	*Pleuronectes americanus*	E: abundant (M)	E: rare January, common February and March, abundant April and May
		L: abundant (M)	L: common February through March and June, abundant April and May, rare July and August
		J: highly abundant (M), rare (T)	J: highly abundant January through May, abundant June through December
		SA: abundant (M)	SA: rare January through February and July, common March and June, abundant April and May
		A: highly abundant (M)	A: abundant January through February, June through July and November through December, highly abundant April through June, common August through October
Hogchoker [1]	*Trinectes maculatus*	E: common (M), rare (T)	E: common May through August
		L: common (M), and (T)	L: common May through August
		J: common (M), and (T)	J: common all year
		SA: common (M), rare (T)	SA: common May through August
		A: common (M), and (T)	A: common all year

NOTES: E: egg stage, L: larval stage, J: juvenile stage, SA: spawning adult stage, Mt: mating adult stage, A: adult stage; (T) tidal fresh, (M) tidal mixing.

REFERENCES: (1) Stone et al. 1994. Distribution and Abundance of Fishes and Invertebrates in Mid-Atlantic Estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Springs, MD. pgs 280.